In the Name of God

IRAN ELECTRIC POWER INDUSTRY

2019 - 2020

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Attention: The statistical data and information given in this publication correspond to the Iranian Calendar year, beginning from 21st. March. Therefore, in the present text, by 2019 is meant a one year period of time begining from 21st. March 2020 to 20th. March 2019

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Foreword

The electric power industry, as the parent and infrastructure industry, plays an important role in the economic development and welfare of communities. Electricity is important because it can be selected as a suitable energy in all areas of economic activities due to the possibility of using modern technologies as well as environmental considerations.
Considering the environment, increasing the efficiency and productivity of electric processes along with the consumption management and reduction of the energy intensity and losses of electricity are other important issues. Attention is being paid to renewable energies and their development in most of the leading countries.

- Regarding the high value aims of 2019, the year entitled by the Supreme Leader of Islamic Republic of Iran as "Year of Production Prosperity", a little drop of the vast dimensions of the services can be measured by considering the growth of two indices of "Installed Capacity" and "Electricity Subscribers Number" from 1979 to 2019. These two indices were 7024 MW and 3339 thousand subscribers, respectively in 1979 that reached to 83506 MW (average annual growth of 6.2 percent) and 36644 thousand subscribers (average annual growth of 6.0 percent), respectively in 2019.

The current report demonstrates the statue of Iran Electric Power Industry in 2019 and the summary of it is as follows:

- At the end of 2019 and despite international sanctions, by installing 16 new power plants as well as renewable energy and distributed generation units with a total capacity of 3038 MW, the total nominal capacity of the Iran's power plants reached 83506 MW which reveals a 3.1 percent growth comparing with the previous year. Therefore, Iran is now among the 16 first countries of the world from the aspect of electric power installed capacity.
- Gross generation of the power plants has reached 326431 GWh (5.6 percent of growth compared with 2018).
- Per capita generation of Iran has reached 3896 kWh (4.3 percent of growth compared with 2018).
- Total electrical energy losses have reached 10.32 percent and the average efficiency of thermal power plants reached 38.6 percent in 2019.
- The electric power transmission and sub-transmission lines length with 1.1 percent growth compared to the previous year has reached 53900 and 74144 km, respectively.
- The electric power transmission and sub-transmission substations capacity has reached 163543 and 114533 MVA with 5.9 and 3.1 percent growth compared to the previous year, respectively.
- Length of the lines and capacity of distribution network transformers (medium and low voltage) has reached 812400 km and 128380 MVA which shows 1.8 and 2.4 percent growth compared to the previous year, respectively.
- Operating and in preparation lines length of optical fiber network are 26833 and 27 km, respectively.
- Total number of electrified villages reached over 57420 by the end of 2019.
- Total number of Iran electric power subscribers, with 2.7 percent growth compared to the previous year, has reached over 36644 thousand subscribers.
- Electricity consumption of residential, public, agricultural, industrial and other sectors has reached 275 TWh which has 5.9 percent growth compared to the previous year.
- Electricity energy interchanges with neighboring countries including Turkey, Azerbaijan, Turkmenistan, Armenia, Pakistan, Afghanistan, Iraq and Nakhchivan has reached 8206 and 1341 Million kWh export and import, respectively during 2019.

- During the past decade by developing the research and innovation in Iran electric power industry, the bases for development and expansion of the existing capabilities and creating new capacities in innovation has been prepared throughout the electric power industry. Trends like privatization, quantitative and qualitative development of electricity market, utilizing renewable energies, efficiency improvement, development of demand side management, loss reduction, value engineering, information technology, increase of human resource power and optimization of the existing installations are among the policies and activities that are currently followed seriously.
- In 2019 with a vision toward future of increasing the installed capacity in power generation section, the trend was toward utilizing gas power plants equipped with the newest and combined cycle technologies, development of profiting from renewable energies, increasing the spinning reserve of power generation system and power system reliability, considering the environmental issues and reducing the amount of pollutants and preparing a competitive environment to attract the private sector participation in power plant construction through B.O.O and B.O.T schemes. Furthermore, the private sector participation in Combined Heat & Power (CHP) generation systems construction in order to simultaneous production of electricity and heat from a single fuel source and development of Distributed Generation (DG) units in order to provide the demand locally and loss reduction of distribution network and reaching to higher efficiency in electric power generation are supported and acclaimed.

According to the subscribers' demand, the main executive programs of electric power industry development in 2020 are as follows.

- Increase of about 2293 MW of new power plant capacity
- Installation of 1800 km of new power transmission and sub-transmission overhead lines
- Increase of 7700 MVA new power transmission and sub-transmission transformers capacity
- Construction of 14600 km medium voltage and low voltage power distribution lines
- Increase of 3300 MVA new power distribution substations capacity

At the end, I would like to appreciate the tireless and sincere efforts of all our dear colleagues in the country’s electric power industry and would like to ask the Almighty God for the success of the whole of electric power industry.

Mohammad Hasan Motevalizadeh,
Chief Executive Officer (CEO),


Plambeck

Power Generation

1. Electric Power Generation

Power plants convert energy from fossil fuels, water behind dams, water, underground steam, sun, wind and etc. into electrical energy. Regarding the limitation of fossil energy resources in the world, increase of using amount of renewable resources has been attractive for experts of electricity industry. On the other hand, due to environmental pollutants the importance of reducing fossil fuels is promoted. In this regard, it is tried to use the latest scientific and technological achievements in electric power industry. According to the aforementioned points, the following policies draw the attention of experts and managers of electric power industry:

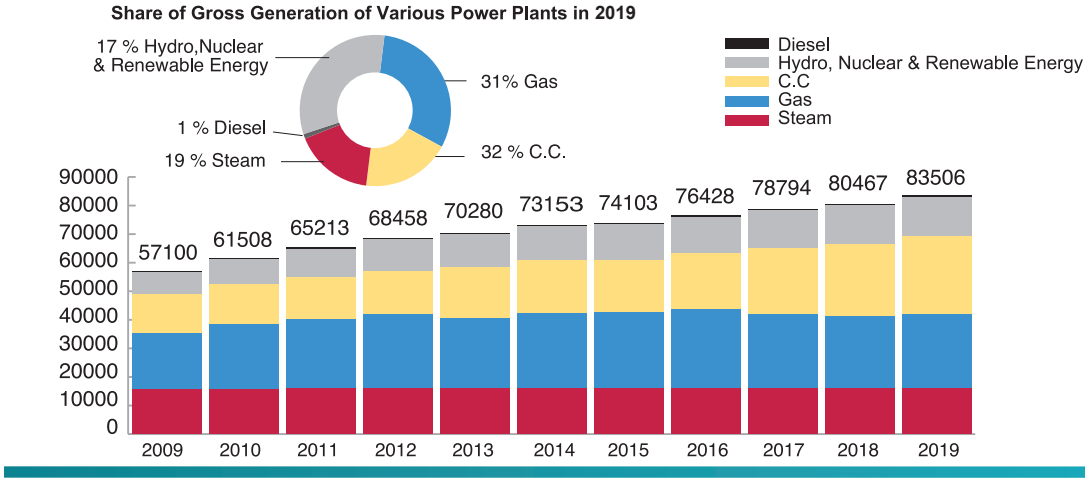
- In order to achieve electric power industry aims, Iran electricity generation capacity increase using new energy and renewable power plants and such as hydropower, wind, solar, wave, etc. is concerned.
- Utilizing combined cycle power plants that have advanced technology, greater efficiency and less pollution is on the agenda.
- The use of electricity in transportation industry to increase productivity, efficiency and environmental protection is among the medium-term objectives of electric power industry.
- In order to increase reliability, flexibility and use of grid generation reserve in low consumption hours, installation of pumped storage power plants is on the agenda.
- In short term, power electronics systems based on silicon (Post Silicon) are used for control and monitoring of electricity.
- Integrating decentralized manufacturing and local storage in the form of new network architecture is considered that is suitable for future competitive market.
- Increasing generation of combined heat and power (CHP) with the aim of increasing fuel efficiency and also development of distributed generation (DG) to the level of 3000 MW to meet local consumption and reduce distribution network losses, is concerned.

Generally, electric power industry development with regard to environmental protection issues in line with developing countries is among electric power industry's short-term goals. According to the experts evaluations by the next 25 years, global energy demand will rise nearly 60 percent and fossil energy sources finishes by the end of the 21st century. Therefore, with the approach to the newest technologies, the idea, design, plan and execution of the work must be done in such a way that electrical energy is always generated reliable, sustainable and compatible with environment.

Furthermore, the most important activities of Generation Dispatching Deputy of Thermal Power Plants Holding Company (TPPH) for optimal operation of thermal power plants are as follows:

- Reducing generation costs.

Fig. (1): Diagram of Installed Nominal Capacity of the Power Plants at the end of the Years 2009 through 2019



- Repair planning of power plants units in accordance with the instructions of the manufacturing company and monitoring its proper implementation.
- Estimating consumed fuel of power plants and daily monitoring of supply and consumption of power plants fuel.
- Achieving technical knowledge and indigenizing manufacturing of power plants required equipment and components in order to reduce the need for foreign purchase.
- Increasing the generation capacity of gas units by cooling the entering air of the compressor.
- Improving and increasing old thermal power plants generation capacity.
- Preservation and maintenance of the environment considering the high amount of consumed fuel by thermal power plants.
- Supervising private power plants operation.

2.The Composition of Different Power Plants Types in the End of 2019

2.1. Steam Power Plants

The overall nominal capacity of steam power plants reached 15829 MW and it contains 19 percent of the country's power plants. The overall operational capacity and gross generation of this kind of power plants was 14891 MW and 85115 GWh in 2019. The utilization factor and average efficiency of this kind of power plants were 65.2 and 36.6 percent, respectively. The amount of fuel consumption of this kind of power plants consists of 17686 million m^3 of natural gas, 172 million liters of gasoline and 5398 million liters of fuel oil.

2.2. Gas Power Plants

In 2019, total nominal capacity of gas power plants was 26180 MW. The points which make this type of power plants attractive are low price, increasing the efficiency (by converting them to combined cycle) and indigenizing manufacturing possibility of major parts of this type of power plant. 31.4 percent of the country's power plants are gas power plants. Total operational capacity and gross generation of this kind of power plants was 21362 MW and 71216 GWh in 2019. The utilization factor and average efficiency of this kind of power plants were 38.1 and 31.6 percent, respectively. The amount of fuel consumption of this kind of power plants consists of 18320 million m^3 of natural gas and 4772 million liters of gasoline.

2.3. Combined Cycle Power Plants

In 2019, total capacity of combined cycle power plants reached 27129 MW. This type of power plants is of great interest in electric power industry due to high efficiency and less environment pollution. The share of these power plants of total capacity of country's power plants is 32.5 percent. In 2019, total operational capacity and gross generation of this kind of power plants were 22067 MW and 131149 GWh, respectively. The utilization factor and average efficiency of this kind of power plants were 67.8 and 45.6 percent, respectively. The amount of fuel consumption of this kind of power plants consists of 24238 million m^3 of natural gas and 5297 million liters of gasoline.

Fig. (2): Diagram of Nominal Capacity of Steam Power Plants Based on age, march 2020

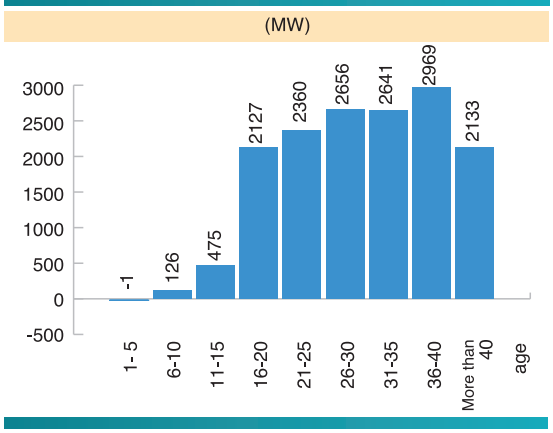


Fig. (3): Diagram of Nominal Capacity of C.C and Gas Power Plants Based on age, march 2020

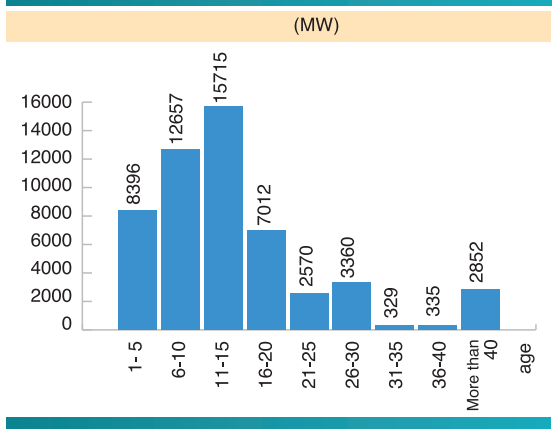
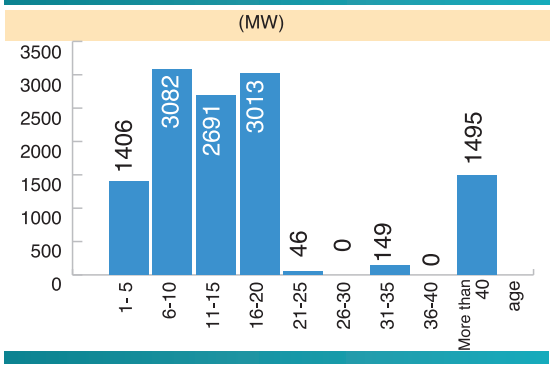


Fig. (4): Diagram of Nominal Capacity of Hydro Power Plants Based on age, march 2020



2.4. Diesel Power Plants

In 2019, diesel power plants participated with a nominal capacity of 439 MW in the process of electrical energy generation and their share of installed capacity was equal to 0.5 percent. The gross generation and the amount of fuel consumption of this kind of power plants were 39 GWh and 12 million liters of gasoline in 2019.

Fig. (5): Diagram of Ratio of Actual Capacity to Nominal Capacity of Power Plants During Summer Season of 2019

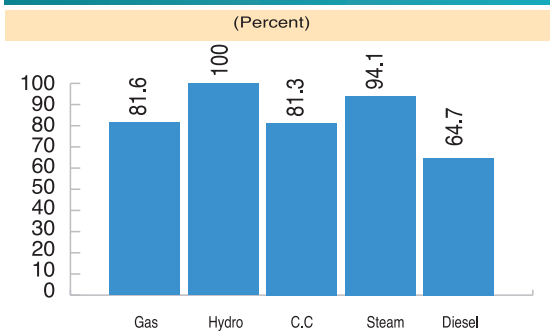
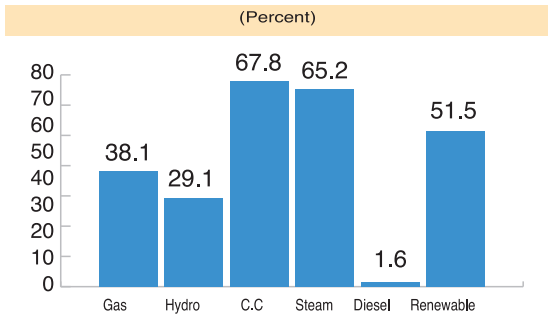


Fig. (6): Diagram of Operational Coefficient of Average Nominal Capacity of Power Plants In 2019



2.5. Hydroelectric Power Plants

Total nominal capacity of hydroelectric power plants reached 12192 MW in 2019 which reveals a 1.4percent growth comparing with the previous year. 14.6 percent of the country's power plants are of this kind. Due to the ability of hydroelectric power plants to control torrents, providing drinking and agriculture water, lack of fuel consumption, lack of environmental pollution, easy operation, low interior consumption, quick stopping and launching, grid frequency control, low repair and maintenance cost and indigenizing manufacturing possibility of power plant equipment, Ministry of Energy (MOE) pays special attention to the development of such power plants. With a 14.1 percent Increase compared to the previous year, gross generation and utilization factor of this kind of power plants were 31082 GWh and 29.1 percent in 2019, respectively.

2.6. Nuclear and Renewable Power Plants

Clean and renewable energies have drawn great attention due to their special characteristics. The related projects have had

Fig. (7): Diagram of Trend of Per Capita Capacity at the end of 2009-2019

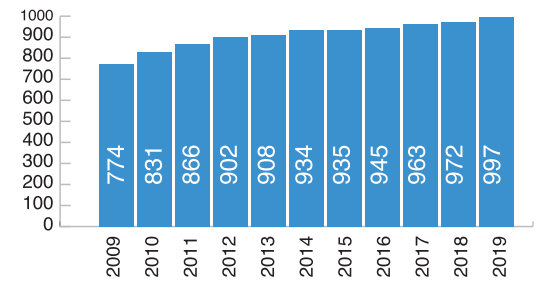
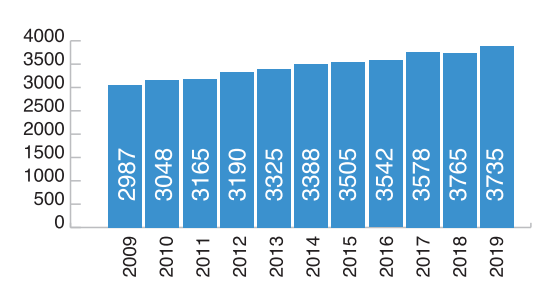


Fig. (8): Diagram of Trend of Per Capita Generation at the end of 2009-2019



good progress. Total nominal capacity of nuclear and renewable power plants reached 1736 MW in 2019 and electricity generation of these kinds of power plants was 7828 GWh which constitutes 2.1 percent of total capacity of all power plants in the country.

3. Operational Power

Power plants in ISO conditions which is the height of free sea level, ambient temperature of 15 °C and relative humidity of 60 percent can operate in their rated power and if their installation location condition is different from the aforementioned, installation location condition is different from the aforementioned, the operational power of power plants decreases which this power is called operational power. Fig. 5 demonstrates the ratio of operational power to the nominal power in summer 2019.

Fig. (10): Diagram of Internal Consumption of Power Plants in 2019

(Percent)

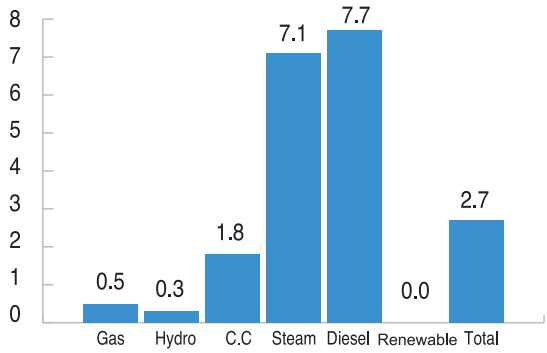
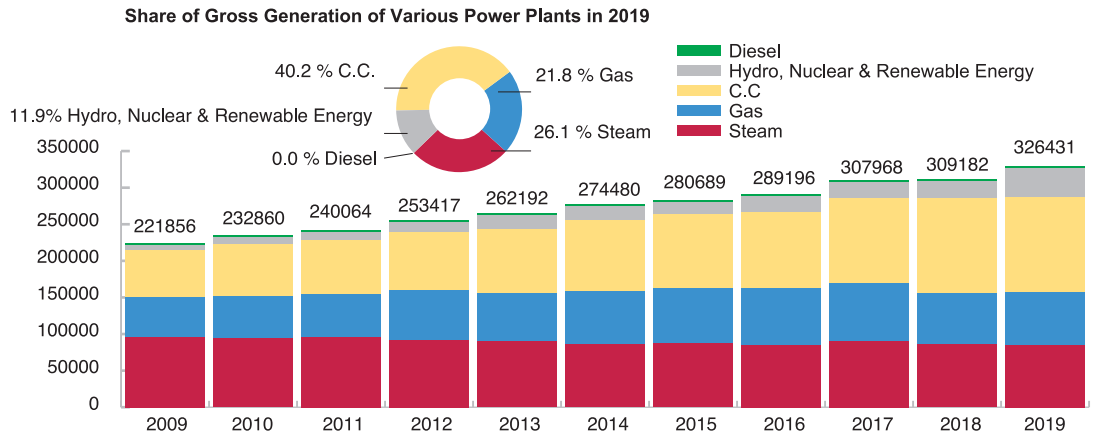


Fig. (9): Diagram of Electicity Gross Generation of Power Plants In 2009 through 2019

(GWh)



4. Power and Production of Electric Energy per Capita

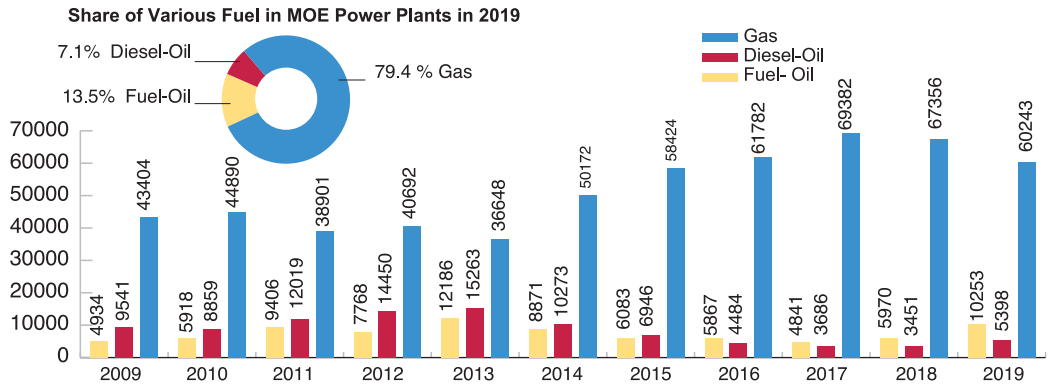
Power and energy production per capita income are two indices of the electric power industry development. If these indicators are more than the population growth, it indicates widespread activity in electric power industry. In 2019, these indices reached 997 Watts and 3896 kWh, respectively which shows an annual increase of 2.5 percent and 4.3 percent, respectively. The population growth was 1.2 percent at the same time interval (Fig. (7) and (8)).

5. Electrical Energy Gross Generation

Iran electrical energy gross generation has been 326431 GWh in 2019 which has a growth of 5.6 percent compared to 2018. 44.1 percent of total generation was supplied by MOE power plants and the remaining 55.9 percent by non-MOE power plants. From the total energy generated, the share of thermal plants was 88.1 percent, hydro plants reached 9.5 percent and nuclear and renewable power plants' share was 2.4 percent. With regard to outside vendors' overseas policy and

Fig. (11): Diagram of Fuel Consumption of MOE Power Plants

(10^6 m^3 or 10^6 Liter)



privatization in electric power industry, an increase in capacity share and generation of power plants of private sector in recent years has occurred. This policy has been continued in 2019 and it will increase in the future.

6. Power Plants Interior Consumption

A part of power plants generation is consumed to supply the main and lateral equipment of power plants which is called the interior consumption and it is different in every power plants. In 2019, the power plants interior consumption was 8871 GWh which constitutes 2.7 percent of the country's total electric power generation. The average interior consumption was 7.1 percent for steam power plants, 0.5 percent for gas power plants, 1.8 percent for combined cycle power plants, 0.3 percent for hydroelectric power plants and 7.7 percent for diesel power plants of gross generation. As can be seen, combined cycle, gas and hydroelectric power plants have less interior consumption and in recent years by development of such power plants, the interior consumption of them has increased.

7. Power Plants Consumed Fuel

Main fuel used in the majority of Iranian power plants is natural gas. Alternative fuel for the steam power plants is fuel oil and for gas and combined cycle power plants is gasoline.
Total fuel consumption was 60234 million m^3 gas and 15651 million liters liquid fuel in 2019.

Gas fuel consumption is superior to liquid fuel for various reasons, including reduced adverse environmental effects, ease of operation and lower repair and maintenance costs. Therefore, extensive measures have been taken to facilitate gas supply to power plants.

8. Generation Reserve Factor

Generation reserve factor of summer operational power of country's power plants is calculated to be 9.3 percent. This factor was about 6.1 percent in 2018. (Fig. 12 and 13)

9. Thermal Efficiency

The average efficiency of the country's thermal power plants belonging to government, private sector or big industries has reached 38.6 percent in 2019.
The most important actions done to increase thermal efficiency of the whole grid are:

A. Eliminating Old Low Efficiency Units

Presently a few old low efficiency units exist in the country's national electric grid which are still operating due to the need for their generation to supply the electricity consumption. In accordance with the provisions of clause 3 of the 293th meeting of Iranian Electric Power Market Regulatory Board, these power plants are mainly put in service at the peak of network consumption (from May to August). Managing and controlling consumption growth in future

years makes it possible to stop such units or decrease their working hours.

B. Converting Gas Power Plants to Combined Cycle Power Plants

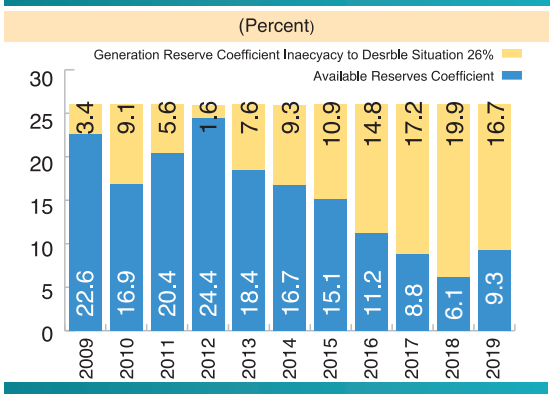
Each combined cycle power plant leads to an average fuel consumption saving of 200 million m3 of natural gas per years which has a very high value and taking into account the international prices of fuel will have a very short payback period.

10. Power Plant Units Repair Scheduling

Power plants units encounter some problems during operation that can affect the efficiency and performance of them. Therefore, integrated scheduling and precise execution of power plant units repairs leads to units' outages prevention and occurred errors removal, emergency exit rate reduction, efficiency increase and country's power grid reliability improvement.

Units repair schedule is of preventive maintenance type and is prepared based on manufacturer's instructions, working hours and units' conditions. The amount of repair schedule in 2019 in thermal power plants section are 623 repair items with 90355 MW. Due to the requirement of country's national power grid, this amount of repair must be executed from August of every year to April of the next year and the units are prepared for operation for the summer peak of the next year. Increase of domestic gas consumption in second half of every year and consequently the reduction of gas delivered to power plants as well as limitations on liquid fuel delivery require that this issue is considered in the power plant units repair schedule in such a way that at any time the units that are not under repair have adequate fuel for supplying the required electricity of the national grid. Fig. 14 demonstrates the repair schedule amount separated by each month. All of the repairs such as checking and periodic or fundamental repairs are done by domestic companies and experts.

Fig. (12): Diagram of Trend of Generation Reserve in Different years (Ratio of Meximum Simaltaneous Consumption to Actual Capacity in a day)



11. Indigenizing Construction of Power Plant Equipment

Indigenizing technology, transferring technical knowledge and national technology growth are requirements of sustainable development and if developing countries do not fulfill these important criteria, they would be soon removed from global competition and considered as weak countries and for performing the development plans would be dependent on developed countries with a great cost.

Self-reliance, transfer of technical knowledge and indigenizing construction in Iran electric power industry are important issues in various sections. Great practical measures in establishing the necessary capacity in affairs of engineering and design, contracting and project management has been done. In addition to providing domestic needs, export of equipment and technical and engineering services to overseas in considerable volume and quality is done in such a way that Iran has increased its share in global markets with presence in international markets and participate in bids and implementation of power plant projects in some countries like Iraq, Indonesia, Pakistan and Turkey. In this regard, considering high potential and available resources to make all equipment inside the country and due to economic saving of construction of products in Iran and a short distance from factories to sites, design for launching different factories for different types of power plant equipment in the country is justifiable and economic. Construction of main equipment of power plants including gas and steam turbines, heat recovering boilers, common boilers for

electrical equipment, instruments and control of power plant, construction different types of blades and fittings is among the advancements in power plant industry.

Considering the acquirement of turbines blades construction knowledge, increase of quality and diversity of products has begun in such a way that turbine blades of under 25 MW to 165 MW are manufactured in blade production companies inside Iran and are successfully installed on units. Simultaneously, blades fittings and other parts of hot path of gas turbines are manufactured in domestic factories.

Due to the created knowledge infrastructure in the country, the project of upgrading V94.2 gas units from its current version to the MAP2B version was designed with the knowledge of domestic experts and was implemented at Sanandaj, Parand, Golestan and Assalouyeh power plants. With this upgrade, 25 MW was added to the nominal capacity and about 2 percent was added to the efficiency of each unit.

Furthermore, reconstruction of the hot parts of various gas units which have important role in cost reduction and on time execution of fundamental repairs are done by domestic factories.

The 100 thousand hours repair operation (RI) of GE-F9, LTE and V94.2 gas units are performed by domestic companies. In 2016 and first 2017, three 25 MW mobile power plant units are designed and manufactured by domestic companies and got in operation in Parand and Saravan power plants (MGT40 unit in Zahedan Power Plant) in the load peak of 2018.

Also, regarding the entitling of 2019 to be the year of “Production Prosperity”, the required scheduling for construction of important power plants equipment is performed.

Distributed Generation (DG) Power Plants

Development of distributed generation (DG) power plants - power plants smaller than 25 MW - is being implemented by the private sector in different parts of the country. Among the advantages of developing distributed generation (DG) power plants is the reduction of network losses due to the closeness of generation to consumption as well as using combustion heat in these plants for the simultaneous production of hot water and steam in the form of CHP and CCHP or pure water production which reveals remarkable efficiency. By the end of 2019, the capacity of under operation distributed generation (DG) power plants has reached 1734 MW (Considering 245 MW self-propelled power plants).

Fig. (13): Diagram of Repair of power plants units by the type of unit

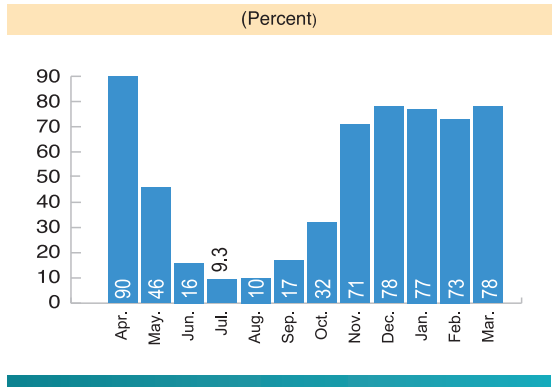


Table (1): Summary of the situation of small scale generators by the end of 2019

No.	Companies	Number of guaranteed purchasing contracts by supervisor (MW)	Contract Capacity (MW)	* Operated Capacity (MW)	Energy Generation in 2019 (MW)
1	Regional Electric Power Companies	214	2967	1061.7	5790628
2	Electric Power Distribution Companies	222	990.3	427.8	
	Total	436	3957.3	1489.5	

* Without Considering 245 MW Self-Propelled Power Plants.

Iran Renewable Energy and Energy Efficiency Organization

Introduction

Growing demand for electricity is one of the problems that human beings face today on the one hand to increase welfare and improve living standards and on the other hand to achieve economic growth and sustainable development. Increasing supply-side capacity and improving energy efficiency on the consumption side are the two main ways to deal with this problem. However, increasing the capacity of thermal power plants will have consequences; Growth of fossil fuel consumption, increase of water consumption and finally growth of environmental pollutants. To address these consequences, the approach of governments and energy policy makers in different countries is in line with the use of clean sources of electricity production and the realization of this important goal is pursued through long-term and short-term planning.

The development trend of the operation of renewable and clean power plants, which is observed throughout the globe, is in line with this approach. The installed capacity of all renewable and clean power plants in the world has increased from about 1000 GW in 2008 to about 2300 GW in 2018, which represents a share of about 33% of the total installed capacity of power plants in the world [REN21.net]. In line with these policies, our country has faced an increase in the capacity of renewable and clean power plants in recent years; At the end of 2010, the capacity of the country's renewable power plants was about 152 MW (about 0.2% of the country's power plant capacity), which with development policies in this area, with a growth of about 500%, reached to 820 MW by the end of 2019 (more than one percent of the total capacity of power plants).

One of the significant achievements of the existing policies in the field of renewable energy in the country is the increase of private sector participation in the development of these power plants; In such a way that the guaranteed purchase contracts of electricity with the private sector are concluded based on the predicted tariffs for various technologies in this field and the payment of electricity according to the aforementioned contract takes place after the operation of the power plant and injection of electricity to electric power network. This issue, along with the transfer of some power plants in line with privatization policies, has caused the share of private power plants in the total number of renewable and clean power plants in the country, with a significant growth of about one percent in 2009, to reach about 90% by the end of 2019.

Fortunately, Iran has great potential for renewable energy in addition to rich fossil fuel resource to meet energy demands. Studies show that the technical potential of wind farms in the country is around 40000 MW and based on forecasts, the estimated economically obtainable amount of wind energy in the country is estimated to be 15000 MW. Regarding sun as a source of energy, the country's climate and geography are also very favorable, as it has about 300 days of sunshine per year, enabling the country to install and utilize solar power plants to meet the electricity demand of the country if some obstacles are removed. In the field of geothermal energy Iran is located on the active geothermal belt and in mountains like Sabalan, Sahand, Damavand and in areas like Khoy, Maku and etc. rich geothermal resources have been proved to exist. Furthermore, Iran is rich in biomass resources. For example, Iran benefits from the potential of electric power derived from municipal solid waste utilizing the incinerator technology for 30 cities with a population of more than 25000 and more than 370 MW and the potential for power generation from agricultural residues of about 810 MW from animal waste sources of 2000 MW.

1.The Necessity of Developing Renewable Energies in Iran

Consideration of renewable energies is a necessity. It has been now proven that economic and social development along with sustainable development, must minimize damage to the environment while optimizing the use of natural resources. Considering this

importance, the necessity of development of renewables energies in the country can be evaluated from six perspectives: economic, employment, environmental, security, urban development and rural development.

1.1. Economical

The energy sector is involved in economic activities in two ways. Firstly, energy is an important economic sector that generates employment and added value in the economy through the process of extracting, transferring, and distributing energy-related goods and services. Secondly, the energy sector has a wave effect on other sectors of the economy.

1.2. Employment

In recent years, the employment rate in the field of renewables has been increasing. As a whole, it can be said that the trend of jobs created from renewable technologies is growing faster than fossil technologies

1.3. Environmental

In recent years, Iran's share of greenhouse gas emissions has increased significantly due to increased energy consumption. In 2015, Iran along with countries such as China, India, the United States of America, Canada, Russia, and Japan has been among the top 10 countries in the world in emission of carbon dioxide. The best choice to reduce environmental pollutants and especially carbon dioxide production is to use renewable resources to supply the required electricity.

1.4. Security

Renewable energies play an important role in enhancing the country's energy security. Considering the dependence of most of the infrastructure and activities of the country and society on energy and the threats related to it especially in conditions of natural and abnormal crises, achieving energy sustainability and security is very important. By strengthening passive defense in the country's energy sector, it will be able to sustain and develop sustainable generation, transmission, and distribution and export energy carriers nationwide in critical crisis situations, while upgrading the vulnerability of critical and sensitive facilities.

1.5. Urban Development

In addition to the impacts of renewable energy use in rural areas, supplying a part of the energy demand in metropolitan areas is also one of the major development priorities in most countries of the world. One of the most important urbanization challenges is the management of household and industrial waste, sewage, and public paths and places which is tied to urban health. The use of renewable energies can play an important role in solving urban problems and in addition to economic prosperity and improving social welfare and improving the quality of life and health.

1.6. Rural Development

Regarding the goal of achieving sustainable energy for the use of renewable energies in rural areas numerous projects are underway. It is estimated that 36 to 41 billion dollars will be needed annually by 2030 to access modern energy.

In our country due to the distance of the rural places of the country from renewable sources and comparing it with the national electricity grid, with the formulation of relevant laws, some services can be provided to this poorest sections of society.

2. SATBA Actions in the Field of Renewable and Clean Energy

The objectives set out in the Sixth Development Plan of the country in the field of renewable energy can be mentioned as follows:

- Increasing the capacity of renewable electricity by at least 5% of the capacity of the country's power plants
- Construction of small scale power plants with maximum participation of people throughout the country especially in poor areas
- Construction of non-governmental renewable power plants in the country for exporting the electricity
- Promoting privatization, expanding cooperation and enhancing private sector capabilities
- Using foreign investment in electricity and renewable energy projects
- Reduction of pollutants and fulfillment of environmental protection and environmental adaptability goals
- Increasing power plant capacity using new technologies
- Effective support for domestic products

Due to the small scale and dispersion of renewable power plants, the apparatus supply chain employment, installation and operation of these plants is high. The construction of clean and renewable power plants has created 42300 direct and indirect jobs in the country.

Table (2) Renewable and Clean Power Plants Constructed by the end of 2019

Power Plant Type	Wind	Solar	Micro Hydroelectric	Biomass Energy	Energy of Heat Recovery Losses & Expansion turbines	Operated Total Capacity
Capacity (MW)	304.92	345.50	96.48	10.56	13.6	772

3. Identifying High Potential Renewable Energy Areas throughout the Country and Evaluating Review Resources

In this process, the country's high potentials (different renewable energy sources) are identified province by province and are presented as an investment package to the applicants of renewable power plants. In 2018, a total of 722 sites were introduced in 10 provinces in different areas of wind, solar, biomass, geothermal and hydroelectric.

4. Preparing Identifying Reports of Potential Sites and Evaluating the Country's Renewable Energy Sources

In order to create a qualitative and quantitative database on the generation and consumption of renewable energies and electricity efficiency, the obtained information from the reports of “Identifying of Potential Sites and Evaluating the Country's Renewable Energy Sources” in each province are used.

5. Efficiency of Electricity Supply and Consumption

The role of policies making and targeting to improve energy efficiency in the electricity generation, transmission and distribution sectors and also conducting optimization studies and reducing energy losses in the electricity generation, transmission and distribution sectors are also undertaken by this organization. In this regard, the major activities carried out in 2018 are as follows:

- Identifying and determining the potential of electricity efficiency (home sector) in Khuzestan province, Bushehr province, Hormozgan province, Sistan and Baluchestan province, Kohkiluyeh and Boyer-Ahmad province, Tehran province, Gilan province, Kerman province, and Ilam province.
- Estimation of productivity potential in the field of energy supply, energy storage and electricity generation from heat loss recovery from industrial processes in Ardabil province, East Azerbaijan province, West Azerbaijan province, Fars province, Khorasan province, Kerman province, Gilan province, Tehran province, Alborz province, Yazd province, Isfahan province, and Chahar Mahal and Bakhtiari province.
- Identifying and determining the energy consumption efficiency potential of the industrial sector in Isfahan province, Tehran province, Fars province, Khuzestan province, Gilan province, Yazd province, and Semnan province.
- Reviewing and updating the energy efficiency potential in the country
- Reviewing and updating the potential of electricity generation from energy recycling in the country
- Evaluating the plans of WHR applicants and expansion turbines
- Technical report supporting electricity generation from heat loss recycling in industrial processes
- Comprehensive atlas of inlet air cooling to gas turbines in the country's power plants

6. Education, Awareness, Informing, and Research

6.1. Training

- The need to obtain self-declaration from the target community considering three decades of structural and instrumental efforts and measures of the water and electric power industry in promoting the above culture in the minds of general and specific stakeholders
- The need to energy consumption management despite the existence of significant sources of energy carriers in the country.
- A look at energy issues, the trend of energy consumption in the country and creating a platform for the promotion and use of new energies.
- The role of excessive consumption in environmental issues, pollution, and global warming.
- The share of new energies in the energy basket until 2020 and the measures taken at the structural and instrumental level of this industry in the country and the related province.
- Protecting the environment by expanding household electricity generation through clean energy and generating economic income.
- The role of psychological techniques in changing attitudes and behaviors
- Familiarity and application of practical and simple solutions regarding energy-consuming devices at home and office.
- The procedure of energy consumption management process.
- Familiarity with simple and practical solutions in the use of energy-consuming equipment at home.

6.2. Public Relations

Attending exhibitions in 2019, including:

- Fourth International Conference and Exhibition and the First National Award for Iran Renewable Energy
- Seventh National Conference and the First International Conference on Iran Renewable Energy and Distributed Generation
- 19th Tehran International Electric Power Industry Exhibition

6.3. International Relations

Participation in global partnerships is done to use the opportunities for communication and interaction between countries and providing credit for accepting our country's sustainable development plans and rights.

6.4. Membership in the International Renewable Energy Agency (IRENA)

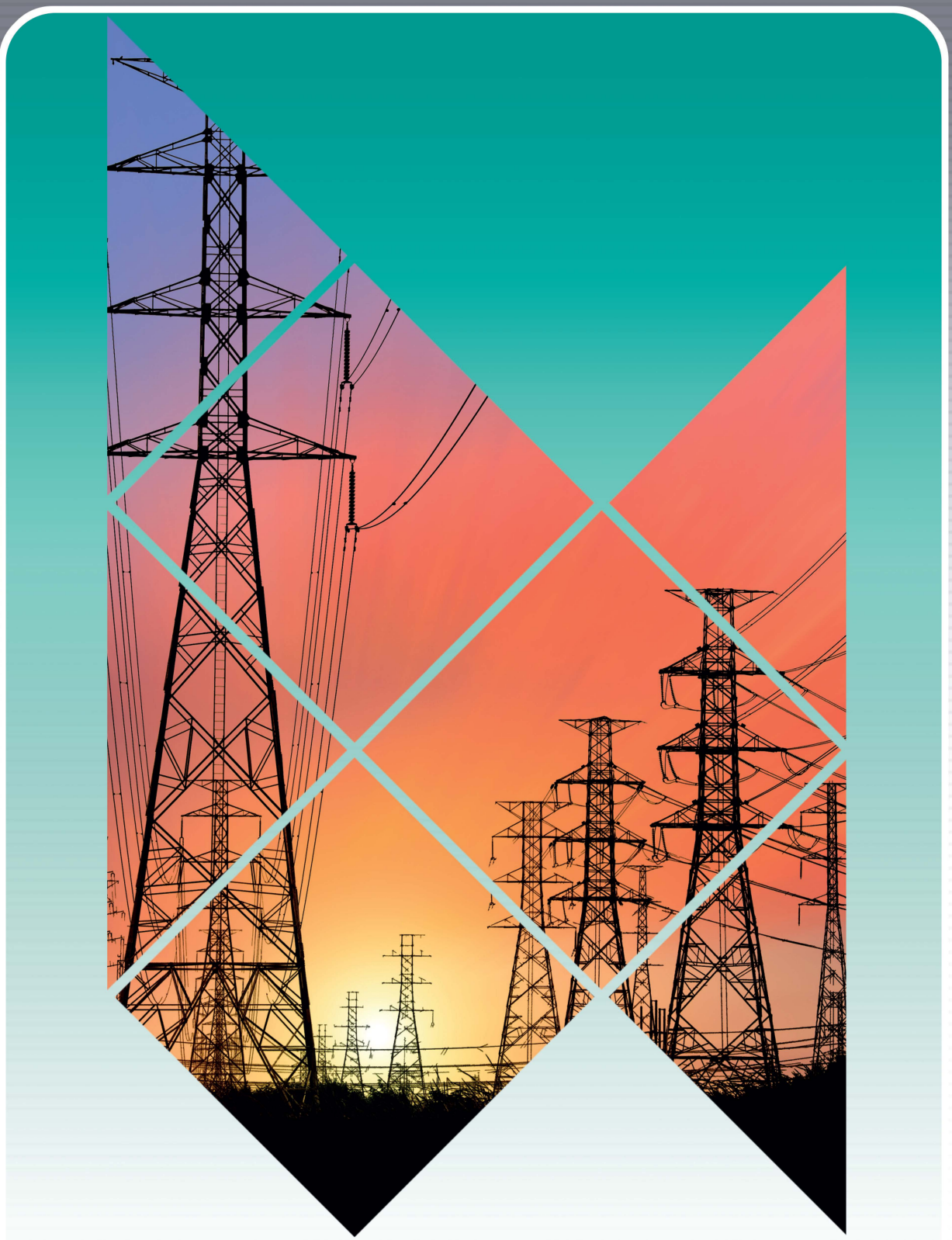
The Renewable Energy and Energy Efficiency Organization (SATBA) with the support of the Ministry of Foreign Affairs (MFA) have provided the membership of our country in the International Renewable Energy Agency (IRENA).

6.5. Establishment of ECO Clean Energy Center in Iran

According to UNESCO's initial proposals, ECO member countries can establish "Clean Energy Centers" to enhance member countries capacities to facilitate and accelerate the development of renewable energies. Under this proposal, SATBA, in cooperation with the ECO Energy Committee, the Ministry of Foreign Affairs (MFA), and the Presidential Center for Progress and Development of Iran (CPDI) reviewed the background, benefits, opportunities, facilities, and conditions of the formation and an agreement was signed with the Presidential Center for Progress and Development of Iran (CPDI).

6.6. Identifying Target Countries and Observing Countries Based On National Goals and Scenarios

Considering the need to identify countries with potential of cooperation with the Islamic Republic of Iran in the two fields of renewable energy and electric energy efficiency, after evaluating all of the world’s countries and prioritizing them on the basis of "economic", "political", "Technological", "market", "social" and "closeness to Iran" indices, 46 countries were identified and observed.



Power Transmission

Electric Power Transmission

Transmission and delivering of electrical energy generated in electric power plants to the electric distribution grids is performed by transmission and sub-transmission substations and lines.

The transmission and sub-transmission substations and lines besides responding to national electric grid costumers are playing a major role in network stability enhancement and electrical energy exchange with neighboring countries.

Electrical energy transmission includes all issues after power generation in power plant and prior to delivering it to sub-transmission and distribution lines. The important points which are discussed in recent years are as follows:

- Due to extent and geographical position of Iran in the region, Iran's electricity grid can actually undertake the centrality and dispatching of neighboring countries electrical grids since Iran electric power industry has a lot of experience in connecting and exchanging electrical energy with electrical grids of neighboring countries such as Republic of Azerbaijan, Armenia, Turkey, Turkmenistan, Afghanistan, Pakistan and Iraq. Currently, seven countries' electrical grids are connected to Iran's electrical network and this is the same as what occurred in the past for Europe.
- Iran transmission network voltages are currently 400 and 230 kV. Recently, lines and substations projects with 765 kV voltage (HVAC) from country's south to center regions have been assigned and is passing its study stages.
- By the end of 2019, from the total 15479 personnel of regional electric power companies, 59.2 percent are working in operation deputies (8428 personnel) and plan and development deputies (734 personnel). Furthermore, human resources of contractor companies which are responsible for stability, development, maintenance and equipment construction of such a huge grid must be taken into consideration.

Transmission and Sub-Transmission Networks Expansion

Transmission and sub-transmission networks expansion planning, development and construction studies are performed based on the electricity consumption forecasting in the future years by power system planning departments. These planning studies are performed for short-term, mid-term and long-term periods. Short-term planning is reviewed after occurrence of peak load every year. After reviewing the status of network and the substations, transmission and sub-transmission lines loads, problems and weak points of the network are identified and by using power system studies software for simultaneous peak load of next summer and with regard to in-progress projects, their priority is

1. HVAC= High Voltage Alternative Current

determined. In middle and long-term studies, time horizon of future 2 to 10 next years is considered and in these studies, the weak points of transmission and sub-transmission networks are identified and with regard to load forecasting for mentioned time, the required proposals will be presented for network optimization, strengthening and development.
Utilization of up to date science and technology in transmission and sub-transmission in different fields are proposed and analyzed as follows:

1. Utilization of Up to Date and Modern Technologies

In line with the construction and development of power plants across the country, power transmission projects using modern technologies is essential so that power supply to the internal network and cross-border transactions does not face any difficulty.
Due to the need to upgrade the country's power transmission network, the construction of 765 kV substations and lines is being undertaken by Tavanir Company. In this regard, it is hoped that this very important project will be implemented in a 7-year period with the support of managers and the provision of liquidity. Of course, other projects related to this project will be implemented in the next phases.
Annually, on average, about 3000 billion Tomans are needed to expand the transmission network in the country. With the implementation of new projects such as high voltage 765 kV, HVDC and GIS substations Indigenization, more funds are actually needed to expand the transmission network.

2. Utilization of the latest achievements in the field of management

Project Management

In the area of modern and advanced management systems establishment, first steps were taken in 2002 and 2003 and as a consequence, electric power industry projects were classified into different groups and for each group, similar structures and processes with processes and activities weighting factors are prepared and defined and in 2005 to 2007, by forming a working group consisting of regional electric companies and Tavanir Co, a comprehensive project management database was designed and given to all regional electric companies to use.
At the same time, important measures in the field of culture, project management knowledge development and regional electric companies staff education was conducted, among which five courses about project management standards can be mentioned. In recent years, Tavanir Co has performed proper actions to provide necessary facilities for establishing project management system in regional electric companies. One of the most important actions is the development of executive methods of project management different processes and preparing the establishment of an integrated pattern of different stages of project management establishment which is notified to regional electric companies in 2015. The aforementioned executive methods are as follows:

- Preparing constitution (charter) of the project
- Management of the project's stakeholders expectations
- Developing job descriptions and project services description and developing a project work breakdown structure
- Development of project schedule
- Project cost management
- Project quality management
- Project human resources management
- Project communication management
- Project risk management
- Project logistics management
- Integrated Project changes management
- Project accomplishment

Another action performed for effective managing and planning of transmission and sub-transmission projects is making the necessary preparations for designing comprehensive project management software and providing necessary information for decision-making and make more proper decisions on the implementation of the project.
It is hoped that in the near future and by expansion of the previous activities in the three fields of staff education, design and utilization of companies' comprehensive project information software and establishment of different project management processes based on established executive methods patterns, a proper platform for effective management of transmission and sub-transmission projects in order to optimize the time, cost and quality of projects is created and the time delays and cost mismatches of projects execution is minimized to the lowest possible value.

Value Engineering

Considering the legal position of value engineering and the widespread development of this subject in recent years and due to the shortage of resources, using value engineering in all projects to manage and optimize resource consumption is inevitable. Value engineering is a very simple method that, in short time, allows the removal of unnecessary components and can play an effective role in the efficient use of resources.
Value engineering is an efficient technique and one of the management and planning tools that has a better position than other techniques in project management and planning to achieve projects goals with minimum cost and quality maintenance.

Strategic Vision of Iran Electric Power Transmission Network

Transmission technical and supervisory department as the authority of supervising optimal operation of transmission and sub-transmission equipment has developed its strategic plan to coordinate the regional electricity companies and has the extent and implementation responsibility of them. The missions can be briefly divided into two parts of utilization and asset management.

In the operation section, the long-term and mid-term strategies can be laid based on the following processes:

System studies, transmission network events analysis, network protection, power quality and costs reduction.

Asset management strategy: it is based on the maintenance, repair, correction and optimization processes. The strategy aims are specific criteria to determine the priorities to be measurable with quantitative indices.

Four strategic subjects are required to perform transmission technical and supervisory department missions are required:

Optimizing the current costs, reliable electricity supply, network losses reduction and informing stakeholders.

An important step to achieve the vision is identifying gaps between the ideal indices and the current situation and this is clearly predicted in the strategic perspective of this department. In order to obtain the aims of the five year strategic plan, the following points must be done:

- Evaluation of operation deputies
- Evaluation of regional electric companies repair and maintenance contractors
- Supervising the equipment entering for the first time to the transmission and sub-transmission network.
- Network proper data to study steady state, dynamic and transient modes (Network Deck)
- Protection setting data collection with the cooperation of Iran Grid Management Company (IGMC)
- Continuous analysis of network and identification of operational weaknesses and threats and bottlenecks.
- Proposal of developing standards, legal regime and necessary guidelines.
- Optimum preventive maintenance (OPM).

- Preparing and updating maintenance and repair database (NET).
- Technical training and implementation and application of modern technologies.
- Establishment and continuation of health, safety and environment (HSE) management systems in companies particularly in regional electric companies operation deputies and supervising and monitoring safety and training and retraining in the field of safety.

Correction and Optimization of Present Transmission and Sub-Transmission Networks

In order to provide reliable electricity and also stability of transmission and sub-transmission networks, improvement and optimization of transmission and sub-transmission networks is also considered by country's electric power industry authorities and experts. Since the routes of transmission lines and substations have various physical, climatic and geographical conditions, sometimes some problems may occur in the functionality if transmission lines and substations which may lead to disturbances in Iran electric power network. Implementation of improvement and optimization of transmission and sub-transmission being more than 48 years old and the problems due to quality of design and construction of some of the equipment is necessary to enhance the network reliability and demands special attention beyond ordinary maintenance and repairs activities. Implementation of such projects shall be in such a way to reduce the problems, limitations and bottlenecks of operation and increase productivity and efficiency of facilities and installed equipment in the network (Figures 19 and 20).
50.5 percent of transmission lines (27185 km) and 32.2 percent of transmission substation (54197 MVA) have been in operation for 20 years and therefore design and implementation of repair and optimization schedule of power transmission network becomes more fundamental and essential every day and it is necessary to provide the necessary financial resources in this field[1]. In recent years, in order to protect transmission network, some guidelines around three topics of replacement, reconstruction, rehabilitation and maintenance has been procured and has been notified to the regional electric companies to improve and optimize transmission lines and substations. The regional electric companies' operation deputies perform the identification of the inconsistent equipment based on studies of events and defects (in terms of short circuit, insulation level and other important factors of the current status of the network and the tasks which have been determined for them and may not meet transmission sector expectations) and in cooperation with the coordination and transmission deputy of Tavanir Co and obtaining approval and funding assignment, performs the improvement projects in the three aforementioned fields. Implementation of the aforementioned projects is done under the supervision of the related office in Tavanir Co which is the transmission technical and supervision deputy.

Repair Scheduling of Electric Power Transmission Network

Considering the breadth and complexity of transmission network, proper maintenance of available equipment and facilities by visiting and performing preventative service and maintenance on a preset schedule is obtainable. Experience has shown that proper implementation of maintenance schedules leads to events, blackouts and interruptions reduction, equipment lifetime increment, costs reduction and network stability and reliability increase.
In this regard, regional electric companies in accordance with the guidelines of maintenance and repair (prepared by transmission technical and supervision deputy of Tavanir Co) provide the network schedules (based on main equipment) for the first and second half of the year.
Since network maintenance programs requires the approval of national or regional dispatching, it

1. Reference: Statistical Report on 53 Years of Activities of Iran Electric Power Industry (1967- 2019)

should be noted that the transmission network is integrated and for the repairs to be done on a line, the possibility of its outage depends on the sensitivity of the line in the network and the circumstances surrounding its generation and consumption. Therefore, repair schedule of transmission network in the region is practically faced with problems and basically, the block analysis of the system is not a proper method to determine the emergency states of system since for outage schedule of each line of the network, it is essential to consider the actual conditions of the whole system. It is obvious that this important decision depends on the upstream level and power industry staff section. To determine the overall network conditions, simulation and calculation prioritized maintenance schedules, essential schedules are analyzed at the office of system planning and studies of Iran Grid Management Company (IGMC) and a part of studies and programming has been assigned to regional dispatching. According to the structure of national dispatching center and regional dispatching centers and based on operation constant guidelines and repair and maintenance scheduling, automated workflow and sending requests plans are predicted through computer communications and are going to be accomplished in near future.

In accordance with the planned and integrated scheduling of network equipment periodic service programs in 2017, a repair committee was formed consisting of Tavanir Co Transmission Network Technical and Supervision Office, Iran Grid Management Co (IGMC) National Grid Dispatching Deputy, Regional Electric Power Co's Operation Deputy Technical Offices and Dispatchings. It has been decided to obtain the main transmission network components outage scheduled plans including lines, transformers, reactors, capacitors and busbars at 400 kV voltage level, between two areas 230 kV transmission lines, and power plants substations from regional electric power companies and after procuring all received plans, the plan will be sent to Iran Grid Management Co (IGMC) National Grid Dispatching Deputy for refinement and integration and proclamation. Implementation of the integrated program will prevent exits due to inconsistency in planning and thereby increase network readiness.

Smart Grid Roadmap

The future trend of electric power industry in all countries in the world is towards smart grids. A grid is entitled smart grid if its components have the capability of bidirectional information exchange (visibility) and decision making and implementation in the field (controllability). Some active international organizations in this field are: NIST (National Institute of Standard and Technology) and IEEE which has recently prepared the standard IEEE Std 2030 - 1011 as well as CIGRE. In order to implement the smart grid, it is required to identify the objects of smartization of the power grid. The main points regarding this aim in various international companies are:

- Increase of network visibility and controllability
- Reduction of environmental issues
- Increasing the generation share of renewable energies in the grid generation
- Adding self-healing capability to the grid
- Load management, peak shaving and network loss reduction
- Increasing network security and reliability

One of the important levers to obtain smart grid is extension of communication network (usually fiber optic) while extending the power grid because in the future electric power grid in order to use renewable energies power and increasing network reliability and security, there would be a need for real-time controlling of it.

Anyway, the first step to making the grid smart is to have a definite strategy in this regard and designing a roadmap. The smart grid roadmap should cover short-term (15- years), mid-term (510-years) and long-term (2030- years) objects and all of the companies activities should concentrate on roadmap's framework after approving it. Now by using the performed studies in pioneer countries in the smart grid field such as Canada, USA, England and South Korea, the roadmap of Iran smart grid is being prepared and in as a practical action, Hormoz Island is selected as the pilot region to implement smart grid in Iran and a part of this project has been executed by now.

Substation Automation System (SAS)

With the advances in technology, substation designers thought of substation automation by controlling the substation through a central computer. This led to omission of human interference in systems and decrease of the problems due to mistake, lack of accuracy, cost reduction and other problems reduction caused by human governed systems.

With emergence of microprocessors, the substation equipment manufacturers tried to replace electromechanical equipment with microprocessor facilitated semiconductor equipment. These devices are known as Integrated Electronic Devices (IED) in industry and lead to the following capabilities:

- Built-in diagnosis and automatic checking; having communication interfaces; capability of data storage and system events; versatility capability
- Integration of all IEDs to the Substation Automation System (SAS) reduces the cost of cabling, communication, maintenance and repairs, operation, reducing the area of the control room, cable, and reducing the area of post and improves the outage and more reliability of electricity service.

The reasons for substation automation system investments in which the use of mechanized information for maintenance and operation is possible, are as follows:

- Digital entering of errors and recording the sequence of events in order to perform event analysis.
- Cost reduction in construction operations, cabling, reducing the control room area and decrease in the post area.
- Utilization of new facilities of modern technology and fast data transfer, maintenance and remote post monitoring.
- All conditions and alarms and measured values are recorded in the computer memory and are controllable and showable using the monitor.
- Increase of usable and up to date information for technical and statistics analysis office and planning office.
- Decrease of consumers' power outage due to faster and easier troubleshooting and as a result troubleshooting time reduction.
- In order to increase the reliability, substation automation system (SAS) should be equipped with Uninterruptable Power Supply (UPS) and devices and equipment that perform simultaneous and parallel backup (Redundancy).
- The operation history of Substation Automation System (SAS) in transmission substations is about twenty five years. The use of such systems increases employees safety who deal with a wide range of electrical equipment and also increases work efficiency and investment saving.

An integrated substation automation control system consists of the following parts:

- Human Machine Interface (HMI) acts as an operational position for employees to monitor the substation conditions and thereby perform routine or emergency operation corresponding to the circuit breakers and this increases the personnel occupational safety and health, as today's substation operator becomes the tomorrow's control center operator.
- Communication networks, computer servers, control softwares, modem and Internet: considering the new nature of such systems and lack of adequate experience for installation and operation of such systems, Tavanir Co as the optimal operator of electric power industry equipment has done many actions to decrease such systems operation problems such as holding educational classes, supporting setting up of various laboratories in electric regional companies, preparation of proper guidelines, holding technical seminars and educational workshops and support for the localization of such systems softwares to reduce problems.

  In this regard, according to the order of the respectable Minister of Energy, support of the production and localization of automation software based on the IEC 61850 communication protocol has been got on the agenda of the Resistive Economy Committee of Tavanir Co.

  Furthermore, considering upgrade of automated substations to digital substations and the use of optical voltage and current transformers, it has been determined that a digital substation is installed and commissioned as a pilot project in Tehran electric power network.

Domestic Built Transmission and Sub-Transmission Lines and Substations

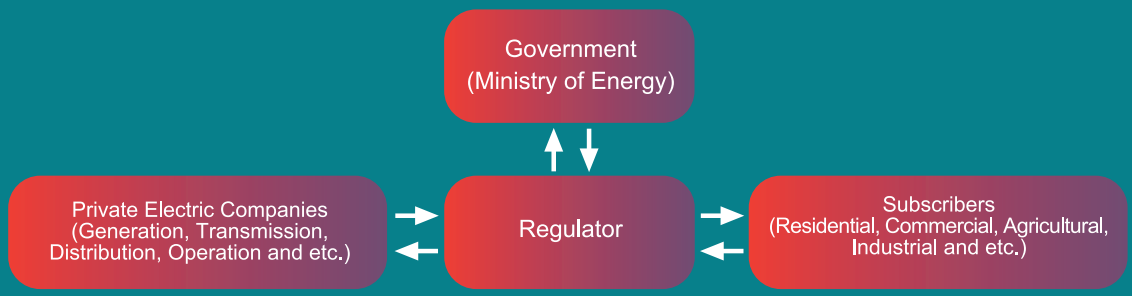
One of the points that has been considered in Iran electric power industry from some years ago and is considered as one of the electric power industry self-sufficiency policy is paying attention to domestic manufacturers to supply transmission and sub-transmission lines and substation devices. After the victory of Islamic revolution and from 1990, the Ministry of Energy (MOE) activities in electric power industry has been concentrated in four definite fields to supply transmission lines equipment which consists of:

- Management of companies that manufacture the required equipment of electric power industry.
- New investment in production of required equipment.
- Construction of engineering, supervisory and contracting companies
- Project management

Iran electric power industry has also been active about investment of private sector in order to activate the islanded capacities of domestic built in supplying transmission and sub-transmission lines and substations equipment and many of electric power industry required equipment especially in transmission section are built inside of Iran and are currently being operated. Now, about 95 percent of equipment construction and execution of transmission projects are performed inside Iran and without dependency to foreign countries. In this regard, Tavanir Co in addition to continuous monitoring of domestic built equipment quality has issued necessary guidelines to sufficiently supply electric power industry equipment from domestic built productions.
In this regard, with the cooperation of reputable universities of the country, effective measures have been taken to design and manufacture High Technology equipment such as protective relays and relay testers which have significant presence in competition with foreign equipment in the field of tenders.

Electricity Power Quality

In countries that competitive electricity market has led the private companies to be present at the scene, this matter due to dignity and rights of subscribers is very important. Fig. 1 demonstrated the relation between government, subscribers and private electric companies.



Relation between Government, Subscribers and Private Electric Companies.

In Iran, the first power quality monitoring was carried out in 20 kV and after that power quality issues were accelerated in regional electric companies. For experimental execution, power quality standard with companies' assessment and auditing guideline regarding the field of power standard obeying was issued in 2002 and different generation, distribution and regional electric companies were asked to evaluate the power quality of their network by measurement and monitoring. Of course, before that the power quality management system and its legal and organizational duties must be defined clearly. As distribution and transmission companies as well as subscribers play role in power quality issue, their legal role in pollution should be defined and special bilateral management contracts between beneficiaries should be defined.

The main reasons for the destruction of electric power quality are the use of non-standard electrical and electronic equipment as well as non-linear loads or power electronics converters especially in industries. Besides the burnout, the energy consuming equipment leads to voltage waveform variation in power grids. Such variations make the voltage waveform non-sinusoidal. In many countries, the importance of power quality has forced the electric equipment manufacturers to comply with specific indices in their products design and production so that less pollution is imposed on power grid.
Power quality monitoring is considered as the first step is to identify network status and provide corrective strategies which can be implemented using three approaches:

Diagnosis Monitoring: This approach is done to determine the source of power quality contamination with the installation of measuring equipment in known buses and based on historical data and after processing such data in specific softwares is analyzed by experts in this field.

Evaluate Monitoring: This approach utilizes permanently installed measurement equipment in grid and this kind of system makes it possible to evaluate and compare the power quality status in different parts of the network.

Predestine Monitoring: This approach is designed and executed to determine the estimated models of power systems for power quality studies. In this monitoring method, only the data of some points of grid are collected and an estimated model of the grid power quality status with the help of specific softwares is provided.

After correct network monitoring and by considering results, the next steps in reforming and improving of power quality includes:

- Removing polluting factors
- Reducing grid sensitivity to power quality phenomena (e.g. using FACTS devices)
- Active or passive filtering
- Obeying standards in the design of electrical equipment
- Changes in the design to reduce loads sensitivity to power quality phenomena

The Electric Power Industry Power Quality Improvement Committee was established in 2009 with the presence of electric power industry experts and university professors with the aim of improving power quality situation. The committee's approach has been improving the level of power quality activities in the electric power industry from measuring power quality parameters to determine the source, providing solutions and implementing them in order to resolve power quality problems. The major activities of the Electric Power Industry Power Quality Improvement Committee with 57 meetings up to now are the following:

- The presence of regional electric power companies candidates in committee meetings to report on the executed activities and existing problems in the network and ultimately guiding the activities correctly and providing solutions by members of the committee
- Defining and implementing national projects on power quality to prevent parallel work (4 cases so far)
- Allocation of credits for implementation of the specified activities in regional electric power companies in the field of power quality
- Monitoring performance of the assigned activities and controlling the expenditure procedure of the devoted credits in the field of power quality
- Developing the required guidelines in the field of power quality

Online monitoring of the country's transmission and distribution network equipment

Considering the need to pay special attention to the management of physical assets in the country's electric power industry, the necessary planning in this regard has been done in order to monitor the equipment instantly and online. Accordingly, in the first step, the power transformers and then the size of the key equipment of the transmission network, such as circuit breakers, overhead and cable lines, etc., are monitored online.
Power transformers are one of the most important devices of power substations, so that the reliability of the network is affected by their proper operation and maintenance. The life of power transformers with an age of over 30 years in the Iranian electric power network is increasing and this requires monitoring the condition of these transformers. There are two methods, offline and online, to evaluate the status of power transformers. The online method is preferable to the other method due to no need for de-electrification, good accuracy and fast detection of power transformer errors. In order to check the online monitoring system of power transformers, reputable companies are planning and taking action to pilot the power transformers of the power grid.

Fig. (14-1): Diagram of Extension-Trends of Power Transmission Lines (KM-Circuit)

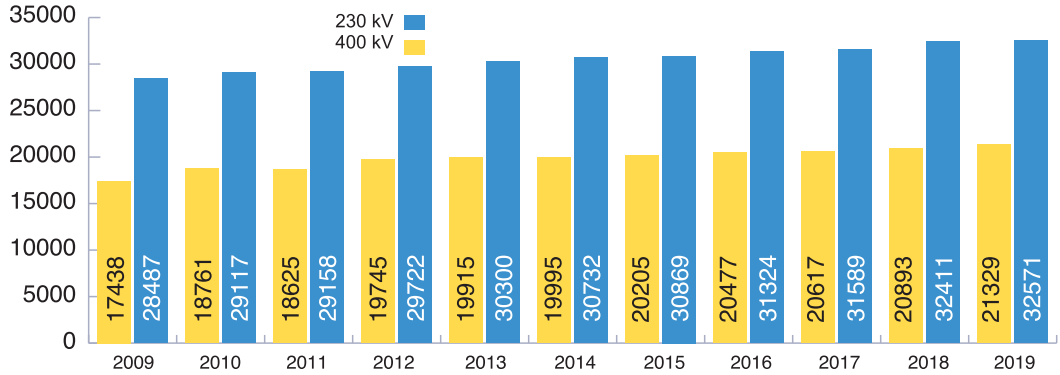


Fig. (14-2): Diagram of Trend of Increase of Sub-Transmission Lines (KM-Circuit)

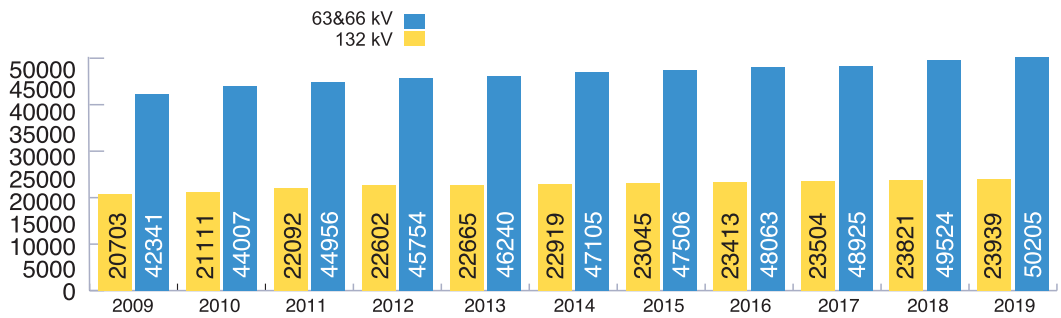


Fig. (15): Diagram of Trend of Increase of Transmission Substations Capacity (MVA)

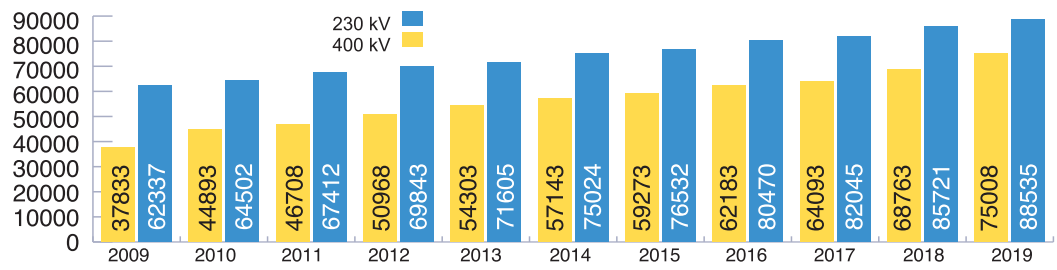


Fig. (16): Diagram of Trend of Increase of Sub-Transmission Substations Capacity (MVA)

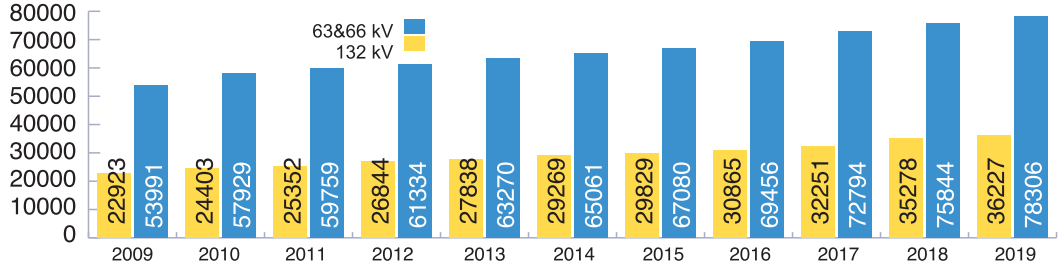


Fig. (17): Diagram of Capacity of Transmission Substations Isolated by Age in 2019 (MVA)

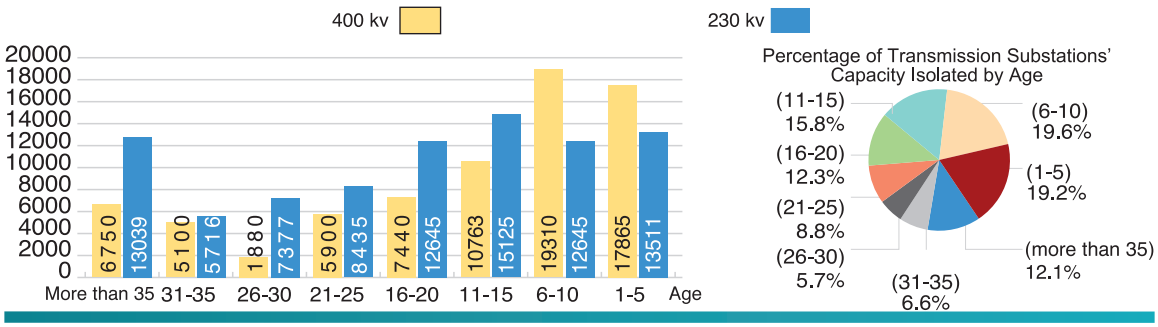


Fig. (18): Diagram of Length of Transmission Lines Isolated by Age in 2019 (Km Circuit)

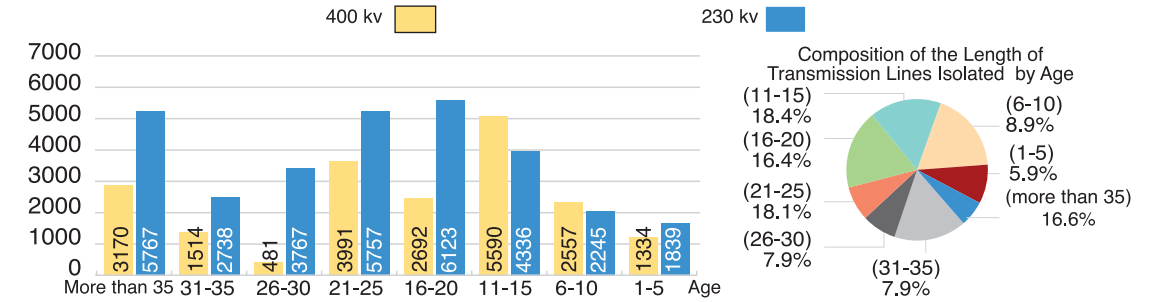


Fig. (21): Diagram of Transmission Lines Length Based on Physical Progress Percent in 2019

(Km-Circuit)

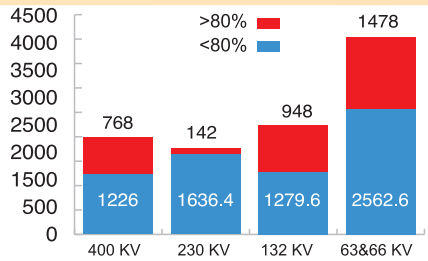


Fig. (19): Diagram of Overhead and Underground Transmission Lines Length on Physical Progress in 2019

(Km-Circuit)

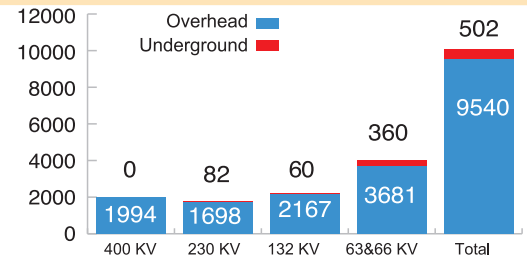


Fig. (22): Diagram of Transmission Transformers and Substations Capacities based on Physical Progress Percent in 2019

(MVA)

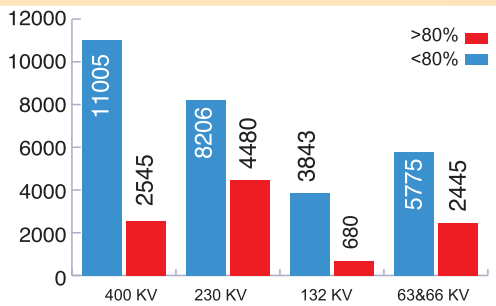
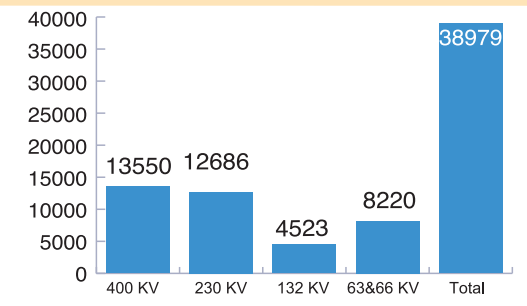


Fig. (20): Diagram of Sub-Transmission and Transmission Transformers and Substations Capacities on Physical Progress in 2019

(MVA)



Power Distribution

Electric Power Distribution

The electric power distribution sector, which is the final stage in the customers' supply chain, has continuously faced the consumers behavior change in quantitative and qualitative terms and by the help of Almighty God and the efforts of all the endeavors of this area has played its important role in the progress of the country. Due to the variety of operational parameters and decision making that includes various social, economic and technological factors, this section has its own characteristics and is particularly crucial due to its direct relationship with people and authorities and the responsibility of responding to subscribers.

Electric distribution companies throughout the country are in charge of electric power distribution. Dispatching and control of such extensive activities in the country require a coherent policy and foresight. It requires not only technical and engineering knowledge but also various views of management, economics and law. It was started with implementation of article No. 44 of Iran's constitution and privatization of electric power distribution companies in 2012 and will be a growing trend.

Policies of Distribution Coordination Deputy

1. Guiding distribution sector to achieve the macro goals of electric power industry
2. Targeting plans and indices of distribution sector during the Sixth Development Plan and 1404 Vision and controlling functionality
3. Increasing the technical stability of covered networks
4. Improving technical and engineering capacity in electric power distribution companies
5. Performing loss reduction, peak shaving and demand side management programs in electric power distribution companies
6. Cooperation in executing policies of article No. 44 of Iran's constitution in electric power distribution companies
7. Transmitting experiences and special activities of electric power distribution companies to each other
8. Supporting the development of consulting and contracting capacities in Iran electric power distribution sector
9. Improving the effectiveness of high order supervision systems in electric power distribution companies
10. Development of smart grid and new technologies in the electric power distribution industry
11. Digital renovation and development of remote services to subscribers
12. Smartization in the consumption sector and providing new services in consumption management to subscribers by using new technologies

Office of Smartization and New Technologies

1- Development of IoT platform in regard of load management
2- Elimination of paper bills
3- Development of an integrated system for managing strategic indicators (Sima plan)
4- Providing all services of subscribers electronically and eliminating face-to-face referrals
5- Promoting office health in the form of mechanized monitoring system in development plans (Sanam plan)
6- Launching the national center for monitoring country's smart meters
7- Completion of FAHAM security and dispatchings monitoring center
8- Development of smart meters for high-consumption subscribers
9- Replacement of electric motorcycles instead of gasoline motorcycles in the service fleets

of electric power distribution companies
10- Development of electric vehicle charging stations
11- Examining the methods of improving power quality in the electric power distribution network
12- Development of guidelines for targeted monitoring of power quality in electric power distribution networks
13- Development of instructions and requirements for hardware and software related to the visibility of electric power distribution networks
14- Setting up the control and management center of distribution sector
15- Providing new solutions in the field of activities related to subscribers' meters reading
16- Project of establishing GIS spatial information system of electric power distribution

Network Engineering and Operation Office

Operation Supervision Deputy

- Establishment and implementation of the basic process in order to improve the operation state
- Asset management with emphasis on improving preventive visit, service and maintenance processes
- Development or updating of the required operating instructions
- Planning in order to upgrade and develop of operation activities in order to organize the outages
- Supervising the establishment of the executive procedure for supervising the design and implementation of standards and electrical installations of all places regarding the earth system
- Lighting efficiency of passages
- Index-based evaluation and supervision
- Field evaluation and supervision

Network Engineering and Management Deputy

"Explaining the strategy and engineering policies in the country's electric power distribution sector and superior supervising of the performance of electric power distribution companies and other effective factors in this field" as the most important organizational task, is on the agenda of the distribution network engineering and management office and managing it is possible by holding accurate and on time information.
In this regard, instructions such as "Description of Engineering Services" (studies of comprehensive electrification plan, the way of connecting distributed generation resources, etc.), and "Technical Instructions for Designing Distribution Networks", "Instructions for Connecting Different Types of Distributed Generation Resources", "Protection Instruction" "Installation, Supervision of Installation, Operation and Service and Maintenance Instructions " (metal and non-metallic compact substations, etc.) in the form of specialized committees consisting of experts of selected electric power distribution companies, consultants, university professors and domestic apparatus manufacturers was prepared and communicated. This process will continue until the explained goals are completed and achieved.
Furthermore, with the aim of creating effective interaction and professional synergy among electric power distribution companies, this deputy has organized a national specialized committee with the aim of establishing a knowledge management base in the field of engineering, and it is hoped that the results will be available to the public in the near future.
All matters under follow are categorized into three main groups:
1- Design
2- Engineering and implementation supervision promotion
3- System studies

Leadership and Reliability Group

- Monitoring, evaluating and improving the quality and reliability of the electric power network
- Strengthening and improving the network against natural disasters
- Upgrading and improving the reliability of distribution networks and customer service
- Guiding, operating and explaining operation policies
- Full development of the online system of knowledge of the outages and events status entitled "RASAD system"
- Index-based evaluation and supervision
- Field evaluation and supervision
- Planning to interact with scientific and academic centers
- Attending meetings and working groups membership

Equipment Quality Control Group

- Performing sample tests in electric power distribution companies, supervision and implementation of technical inspection system in the process of supplying goods in the electric power industry was followed.
- Exchange of experiences with reference laboratories, consultants, university professors, equipment manufacturers and suppliers continued.
- Holding several meetings with representatives of electric power distribution companies and Iran Goods and Services Numbering National Center (GS1) to implement the coding and equipment tracking system
- So far, 99 instructions for the technical specifications of the multi-purpose equipment (initial versions and editions) have been announced, and 10 draft editions have been finalized and are ready for approval.
- So far, 7 instructions for technical specifications of special equipment have been notified and 4 drafts have been finalized and are ready for approval.
- So far, 2 instructions for technical specifications of hot line equipment have been announced and 6 drafts have been finalized and are ready for approval.

Safety Office

- Communicating the superior policies of the Ministry of Energy's Health, Safety, Environment and Social Responsibility Regulations to electric power distribution companies
- Determining the title of safety measures for electric power distribution companies to prepare the annual operational plan based on the aforementioned regulations
- Determining the safety budget and supervising its expenditure in the form of annual safety plans
- Continuous monitoring of the performance and safety status of electric power distribution companies and preparation of management reports
- Investigation of major events caused by the work of electric power distribution companies
- Development of executive rules and safety instructions required by electric power distribution companies
- Establishment of safety committees of Region 9 of the country with the presence of electric power distribution companies of the region and supervising their performance
- Review of safety research projects of electric power distribution companies
- Planning and implementation of annual national supervision of electric power distribution companies
- Carrying out the necessary planning to improve the level of safety awareness of employees, contractors, subscribers and citizens
- Carrying out the necessary planning to improve the level of safety awareness of jobs related to the industry

Distribution Planning Office

- Reviewing and finalizing the operational plan (internal agreement) and the implementation criteria of the budget of electric power distribution companies
- Monitoring and revision of technical and non-technical indices of electric power distribution companies up to the prospect of 1404 according to the performance of previous years
- Performance evaluation (conference of senior managers, Shahid Rajayi Festival at the provincial level, etc.)
- Monitoring the electricity market, energy exchange and the performance of electric power distribution companies and making effort to develop the companies with the aim of helping to improve the competitive market
- Developing guidelines for electric power distribution service rates with the aims such as calculating the average electricity transit rate in electric power distribution networks, operational cost rates, electric power distribution service rates and the amount of allowable losses in the electric power distribution sector
- Extraction of major problems of electric power distribution companies in the field of finance and trade
- Providing operational solutions to get out of the future debts of the Tax Administration and the Social Security Organization
- Providing a new solution for providing resources based on asset management methods and general conditions of the country
- Reviewing the price list of the basic unit of the electric power distribution of 2019
- Holding meetings to resolve disputes between contracting and purchasing goods contracts with stakeholders
- Leading the business field of electric power distribution companies
- Answering the questions raised by the electric power distribution companies in the field of transaction regulations and other related criteria
- Reviewing and responding to supervisory organizations
- Investigating and resolving the contractual dispute between the subscribers and the electric power distribution company in the field of transfer of subscription and substation land

The Most Important Activities by Subscribers Services Sector

1- Fundamental goals in this sector including subscribers' admission systems, the readings of measuring equipment, the issuance and distribution of electricity bills, information communication, collection of debts and payment of electricity bills

2- The expectations in this sector are:

- Recognizing and applying new methods for speeding up the service to subscribers
- Improving the communication system with subscribers
- Establishing an efficient supervision system in subscribers system
- Development and improvement of the automation system in the field of admission of applicants
- Development of multi-tariff measuring equipment for subscribers
- Replacement of traditional methods of reading, distributing and collecting electricity bills (considering technical and economic viewpoints)

3. Previous Actions includes:

- Control and monitoring of information of electricity bill of the country (Sakna) System
- Establishment of telephone payment system and provision of remote services 1521
- Providing electronic services through the companies' websites
- Establishing a national electricity subscriber database to focus on data of interactions, consumptions, and expenses
- Addressing requests and grievances of electricity supply and receiving, processing, and responding to people's requests

- Preparing monthly reports from:
- Selling energy and collecting debts based on periodic reports from electric power distribution companies
- Mehr houses project: in relation to the number of documents formed in electric power distribution companies in order to provide electricity for Mehr houses projects
- Smart water and electric power meters in relation to the number of wells in the whole country, electrified, and in progress and insuring household electricity subscribers
- Subscribers Integrated Services Infrastructure (Fakhim) which is a developed and applied national system for calling the operational reports to provide services throughout the country

The Most Important Activities by Demand Side Management Sector

Office of electric power demand side management and subscribers services has been performing a broad planning for demand side management since 2011. Such planning are performed in regional electric power companies and electric power distribution companies especially in the period from May 15 to August 15 of each year which is the peak time in Iran National Grid. Stability and reliability of Iran National Grid in peak time is the result of such planning.

1- Measures taken to attract the cooperation of industrial subscribers

- load reduction program during peak hours plan
- Industrial operational reserve plan
- Scheduled 24-hour load reductionshedding plan
- Transfer of weekly vacations from Friday to one of the working days of the week plan
- Determining the working hours of single-shift industries plan

2- Attracting the cooperation of agricultural subscribers in the related demand response program

- Scheduled load cutting plan for agricultural water well subscribers (Tariff 3-a)
- Scheduled load reduction plan for agricultural demand subscribers (Tariffs 3-b and 3-c)

3- Attracting the cooperation of subscribers with emergency/self-supply generator

Subscribers with emergency/self-supply generators have used these generators to supply part or all of their consumption during the required hours of the network.

4- Implementation of TOU program at the level of regional electric power companies and electric power distribution companies

5- Attracting cooperation and participation of commercial subscribers (guilds)

6- Attracting cooperation of CNG stations

7- Attracting the cooperation and participation of public and administrative subscribers in energy consumption optimization methods and load response program

- Public subscribers are entitled to receive bonuses in their electricity bills by reducing the load by at least 10% by using the load response program for this group (reduction of scheduled load during peak hours).

8- Informing and cultivating consumption management for women working in offices and housewives

9- Cultivating and teaching the basics and strategies for optimizing electricity consumption for students as the future builders of the country

10- Cultural and information activities in the country in order to teach energy efficiency

11- Carrying out research, study and educational projects

12- Supporting national university plans and projects for electricity consumption management

13- Participating in exhibitions in accordance with the goals of consumption optimization

14- Attending regional, national and international conferences

Summary of performance and peak reduction report of the Consumption Management Office in 2019		
No.	**Project Description**	**National Electric Power Grid Reduced Demand (MW)**
1	Industrial subscribers: Implementation of the scheduled load reduction plan during peak hours by attracting the cooperation of 18514 industrial subscribers in regional electric power companies and distribution electric power companies	o Network peak day: 1219 MW o Maximum performance day: 1117 MW o Maximum performance of this plan: 1594 MW
2	Industrial subscribers: Implementation of industrial operational reserve plan in cooperation with 806 industrial subscribers in regional electric power companies and distribution electric power companies	o Network peak day: 488 MW o Maximum performance day: 680 MW o Maximum performance of this plan: 736 MW
3	Industrial subscribers: Implementation of scheduled 24-hour load reduction/shedding plan with the cooperation of 1536 industrial subscribers in regional electric power companies and distribution electric power companies	o Network peak day: 545 MW o Maximum performance day: 818 MW o Maximum performance of this plan: 931 MW
4	Industrial subscribers: Implementation of weekly holiday shift from Friday to one of the working days of the week with the cooperation of 136 industrial subscribers in regional electric power companies and distribution electric power companies	o Network peak day: 0.8 MW o Maximum performance day: 1.3 MW o Maximum performance of this plan: 16 MW
5	Agricultural subscribers: Implementation of agricultural subscriber load response plan in order to reduce the summer peak load with the participation of 78,373 agricultural subscribers	o Network peak day: 1016 MW o Maximum performance day: 1091 MW o Maximum performance of this plan: 1163 MW
6	Business subscribers: Implementation of the scheduled load reduction plan with the cooperation of 6753 commercial subscribers in electric power distribution companies	o Network peak day: 33 MW o Maximum performance day: 51 MW o Maximum performance of this plan: 71 MW
7	Administrative subscribers: Implementation of the scheduled load reduction program with the cooperation of 12358 administrative subscribers in electric power distribution companies	o Network peak day: 184 MW o Maximum performance day: 173 MW o Maximum performance of this plan: 184 MW
8	Self-supply generators: Implementing the program of using self-supply generators with the cooperation of 1669 generators in electric power distribution companies	o Network peak day: 88 MW o Maximum performance day: 102 MW o Maximum performance of this plan: 248 MW
9	CNG gas stations: Implementation of the scheduled load shedding program with the cooperation of 762 stations in electric power distribution companies	

- Load reduction at the network peak day: load reduction resulting from each plan at the time of national electric power network peak
- Load reduction at maximum performance day: load reduction resulting from the execution of plan on the day the maximum performance of load response programs occurs simultaneously.
- Load reduction at maximum performance day of each plan: maximum load reduction resulting from the implementation of each program separately.

Electric Power Distribution Networks

Electrical energy is distributed in medium and low voltage levels and their statuses are as follows by the end of 2019:

Medium Voltage Network

Medium voltage network has usually 20 kV voltage level and in some parts, 33 kV and 11 kV are used for electricity distribution. Medium voltage lines transmit electrical energy from sub-transmission substations and provide directly the required electrical demand of big and high-consuming subscribers like factories, agricultural centers, services and etc. The electric power distribution network experts try to use modern scientific and practical methods to decrease loss and outages, provide secure and high quality electricity and gain satisfaction of electricity subscribers. In this regard, the medium voltage networks expanded in 2019 and the actions to optimize them were carried out, simultaneously.
Length of medium voltage networks with an average growth of 1.7 percent compared to the previous year reached 439000 km. Fig. 25 demonstrates the trend of length of overhead and underground medium voltage lines.

Low Voltage Network

Low voltage lines supply the electric power of conventional consumers. These lines are the last part of the interconnected electrifying chain of electric power grid that supply final consumers' electricity. Iran low voltage lines are three phase 380 V and single-phase 220 V and 50 Hz frequency. This network has in majority overhead lines except in some regions of big cities that have problems like lines safety borders, urban density and other limitations that leads them to use underground cables.
In 2019, length of low-voltage lines had an average growth of 1.8 percent compared to the previous year and reached 373000 km. Fig. 26 and Table 41 demonstrates detailed development description of low voltage lines.

Distribution Substations

Transformation of medium voltage to low voltage for the use of residential and low consuming subscribers is executed through distribution substations. Distribution substations in the grid are installed in the form of ground (installation in covered area) and overhead (installation in free air and over towers).
Ground substations are devoted to areas inside the cities and in places with high consumption subscribers and their characteristic is higher capacity in comparison with overhead substations and maneuver capability in the grid through the installed equipment beside them. Figures 27 and 28 and Table 42 shows the trend of distribution substations expansion. One of the limitations of ground substations in big cities and areas with high field price is finding proper location for construction of ground substations. In this regard, compact substations design has helped in decrease of required space and omission of this limitation. With the increase of number and average consumption of subscribers, distribution substations number including ground and overhead substations has also increased in such a way that by the end of 2019, the number and capacity of ground transformers reached to 40658 units and 29803 MVA, respectively. Furthermore, the average capacity of each ground substations was 733 kVA.
The number and capacity of installed overhead transformers were 706683 units and 98577 MVA, respectively. The average capacity of each overhead substation was 139.5 kVA. The growth of distribution transformers number and capacity compared to the previous year were 3.1 and 2.4 percent, respectively. The point that is considered as a development index in the design of distribution networks is the transformers' installed capacity per each subscriber that was 3.5 kVA by the end of 2019.

Villages Electrification

An analysis of the necessity of utilizing new energies in order to electrify remote and impassable unelectrified villages

The advantages of photovoltaic systems are simplicity and ease of installation and operation, easy transportation, high reliability, lack of mechanical parts, environment friendly and not requiring fuel and fuel problems that has placed photovoltaic systems in a superior position than national grid for electric power generation and electrical energy supply for rural regions. Other reasons for using photovoltaic systems are:

1. Villages dispersion and long distance from national electric power grid that from technical and economic aspects needs high per capita in order to be electrified from national electric power grid.
2. Roadless and impassable villages which electrifying them is very difficult because of inaccessibility and lack of electrification by distribution network. Therefore, utilizing new energies in order to electrify them is the most proper way.

Villages' Electrification Program through Renewable Energy

By the end of 2019, 231 villages with 2557 households are electrified through renewable energy.

Jihadi Plan for Losses Reduction

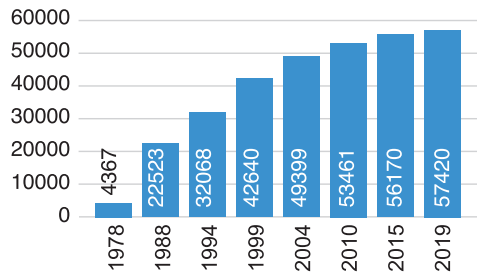
In line with resistive economy policy by Iran Revolution Supreme Leader, energy losses reduction in distribution networks is one of the important activities of the electric power industry. According to the data recorded and after a period of six years since the beginning of the jihadi plan for losses reduction, at the end of 2019 it was equivalent to 9.76%, which has decreased by 0.65% compared to the previous year, and for the first time, it has become single-digit and has reached global and regional averages.

Specified subjects for losses reduction

In the expert meetings, the necessary measures have been explained in the following five areas and the electric power distribution companies have been notified in the form of the approvals of the superior losses reduction committee:

- Reducing feeding radius of distribution and sub-transmission tations
- Upgrading and improvement of measuring and control devices to counteract the manipulation of the meter
- Reengineering distribution networks
- Improving the quality of distribution network equipment
- Improving the observability and measurability of electrical energy in the network

Fig. (23): Diagram of Number of Electrified Villages



Some activities related to the above fields

- Using low-loss transformers instead of conventional transformers.
- Use of small transformers to reduce the length of the low voltage distribution network.
- Development of self-supporting cables to increase the cross section of conductors and prevent unauthorized branches.
- Communicating equipment quality control instructions.
- Determining the allowable limit for non-reading of normal urban measuring equipment to less than 2% and normal rural to less than 3%
- Strengthening and equipping inspection teams to deal with unauthorized electricity.
- Defining the reference meter and compiling instructions on how to use it.
- Installation of reference meters for the purposes of Article 8, sub-sanctuaries and special areas.

- Accurate estimation of special uses such as traffic lights, religious occasions, etc.
- Quick repair of defective measuring devices and quick installation of measuring devices for applicants waiting for installation.
- Using appropriate CTs for demand subscribers.
- Announcing the development of instructions for the development of small distribution substations.
- Changing the configuration of low and medium voltage networks.
- Correction of loose connections.
- Developing the use of smart meters for demand subscribers.
- Prioritizing the supply of electricity to demand subscribers through medium voltage.
- Evaluating the performance of technical indicators of electric power distribution companies

These activities have been followed up and implemented in the form of executive plans by all relevant departments in electric power distribution companies and their respective managements in Tavanir Co and the office of losses reduction periodically monitors its effective and continuous implementation and compliance with communications policies.

Fig. (24): Diagram of Number and Capacity of Distribution Network Transformers

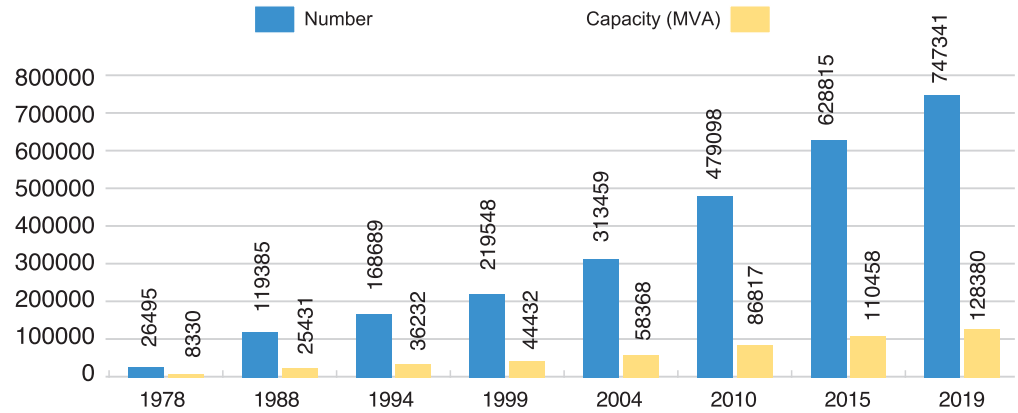
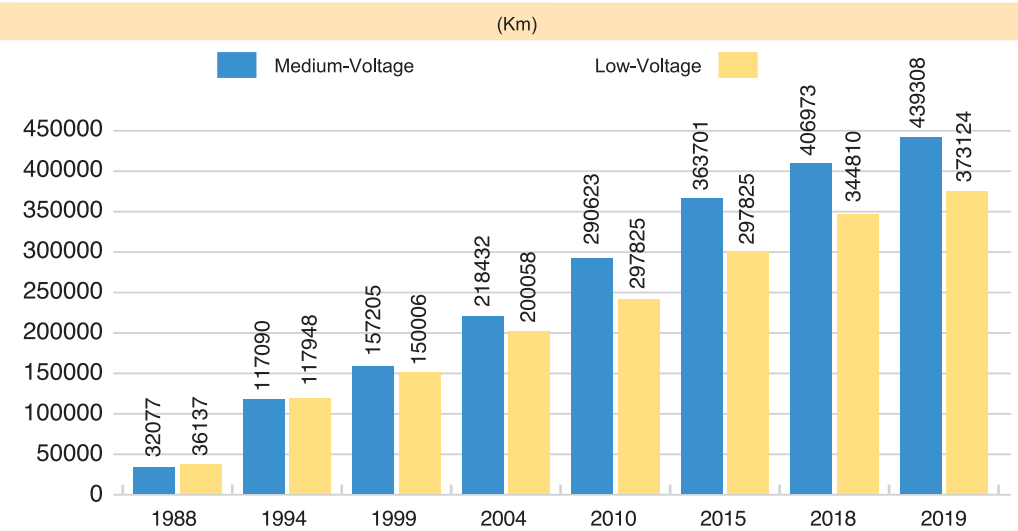


Fig. (25): Diagram of Length of LV/MV Distribution Lines



Load and Generation Leveling

Generation and Consumption Balancing

In 2019, electric energy consumption has been increasing 5.9 percent comparing with it 2018 and reached 275094 Million kWh. The management of the electric energy consumption and generation is defined as utilizing a collection of policies and implementations that leads to balancing between mentioned sectors. Generation management has brought all his effort in the field to supply a reliable energy which is economically assured.

The electrical energy can not be stored and must be consumed as it is produced. Hence, generation management is subject to specific constraints for the supply of electrical energy and only demand side management must be done. There are two factors in this regard: the first one is efficient and adequate consumption and the second one is the transfer of consumption from peak hours to other hours of the day. The first factor will decrease the consumption and the second factor will decrease the peak of the network. Achieving these goals is possible by expanding the culture of efficient energy consumption, especially through mass media.

One of the ways to keep the output of large power plants steady and achieve optimal efficiency is the use of pumped storage power plants. In such power plants at non-peak time, water is pumped from the lower tank to the upper tank by electrical energy and at peak time, water is sent from the upper tank to the lower tank and electricity consumers receive electricity from the conversion of the resulting potential energy to electrical energy at peak times that more electricity is required and in this way the network load factor improves.

Fig. (26): Diagram of Decrease Rate of Peak Load of Bulk Power System by Accomplishing the Large Scale Industries' Scheme

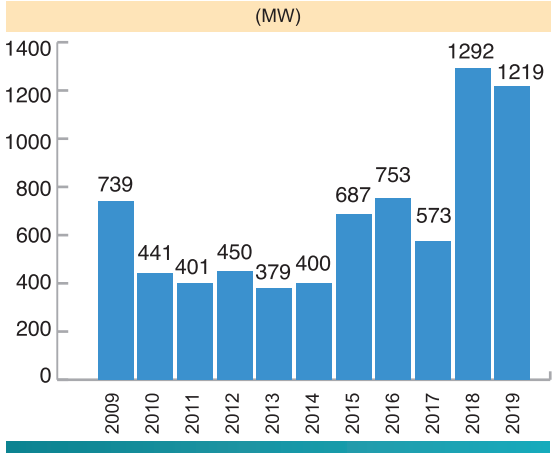
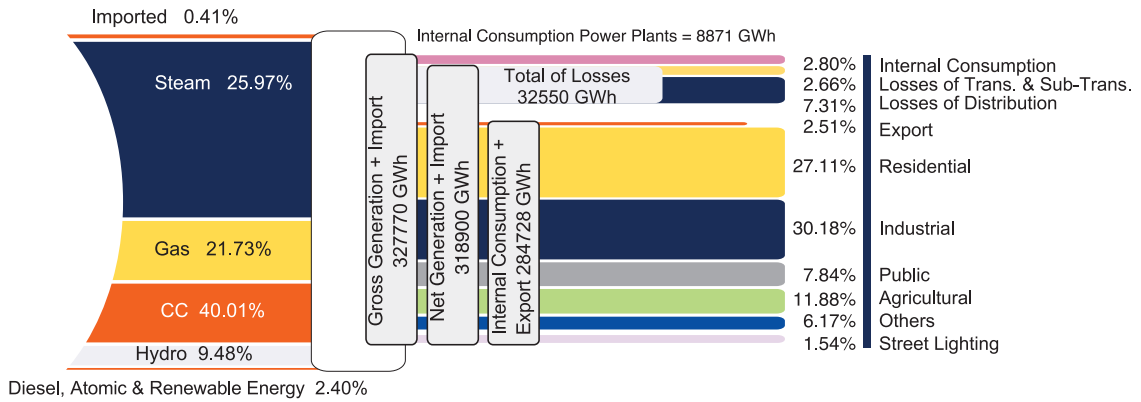


Fig. (27): Diagram of Energy Generation and Consumption Levels in 2019



Power Consumption Management

The measures carried out by power management office in regional electric power companies are as follows. (The actions performed by electric power distribution companies in power consumption management are provided in the distribution section explanations.)

- Cultural activities and awareness
- Studies on load and consumption patterns
- Evaluate potential solutions and their priority
- Demand side management programs
- Follow-up enforcement activities

The above points are classified in the regional electric power companies as follows:

- Study activities
- Operating activities
- Analyzing results and proposing report

The above activities are carried out in the short term (1 to 2 years) and in the medium term (3 to 5 years).

1. Monitoring and estimating the peak load status of the company's previous and future years simultaneously and non-simultaneously with the national grid peak load including the amount and time of the peak occurrence.
2. Extracting hourly information of each of the major industries and subscribers of the region, determining load profiles, load curves, industries loads share in the peak, monitoring the status of customers and applicants in the coming years, the status of loading from different parts of each industry and studying how they coincide with each other, in which these studies are conducted, the types of industries and the range of electricity demand per industry.
3. Examining the saving potential in peak load and energy consumption of industries, including activities such as reviewing appropriate holiday and annual repair solutions, energy audits, and so on.
4. Examining the potential of using diesel generators in the industry, taking into account technical and economic constraints.
5. Examining the suitable solutions for using electric and heat cogeneration systems and renewable energy technologies by conducting technical and economic studies
6. Evaluating the savings potentials through implementing appropriate solutions to reduce transmission and sub-transmission losses
7. Examining the impact of using smart systems to reduce energy consumption in substations and industries in the area

Executive Activities

1. Closer cooperation with the regional industries and holding regular meetings with industry energy authorities and monitoring the implementation of decisions taken with industries.
2. Providing or designing and installing appropriate software and hardware for extracting and storing hourly data of the regional industries in the regional electric power company area and, if necessary, planning to replace the measuring equipment to monitor more accurately the consumption of industries.
3. Encouraging industries to implement the results and recommendations of energy audit studies.
4. Making efforts and cooperation to eliminate obstacles for the use of existing diesel generators in the major industries and, if possible, to collaborate on creating facilities for fuel supply, operation and synchronization with the grid.
5. Holding training sessions and seminars for energy managers and industry workers in the region.

6. Periodic and continuous reports on the consumption management by regional electric power companies regarding the declaration of activity status.

Research Projects and Studies and Their Results

1. Reviewing the status of industries by industry type, current status, saving potentials and actions taken.
2. Existing Status of sub-transmission, transmission and power plants in the region, in terms of domestic consumption and saving and improvement potentials and actions taken.
3. Reporting the results of measures taken in all regional industries, substations and power plants in the area of reducing energy consumption and peak load and comparing it with previous years.
4. Future prospects and proposing proposals for future activities.

Power Consumption in Various Sectors

At most of world's countries, power electric consumers are divided into 6 sectors of: residential, public, other consuming, industrial, agricultural and road lamination. By the end of 2019, number of subscribers and electrical energy consumption has been 36644 thousand and 275094 Million kWh, which comparing with the previous year 2.7 and 5.9 percent growth is detected, respectively. In the following, the amount of electricity consumption and the number of subscribers and the share of each tariff in 2019 are mentioned.

1. The Household Sector

Electricity consumption in this sector is mainly for lighting and home appliances and cooling devices. In 2019, the share of energy consumption in this sector was 32%. The number of subscribers and household energy consumption was 29427 thousand subscribers and 88500 million kWh, respectively which shows a growth of 2.4 and 4 percent, respectively. The average energy consumption of each household in this year was 3007 kWh which is 1.6 percent higher than 2018.

2. The Public Sector

The consumers in this sector include: governmental departments, parliament, judiciary, joint housing and non-residential units, army, shrines, cultural centers, educational centers, Hussainyahs, mosques, sports centers, welfare facilities, Victims and handicapped and old men and old women care centers, baths, cold stores, pumping and water treatment plants for urban and rural liquor, bakeries' sewage networks, and so on.
In 2019, the number of subscribers in this sector grew by 4 percent from the previous year to 1732 thousand subscribers and electricity consumption increased by 6.3 percent to 25589 million kWh. This year, the average power consumption of each public subscriber was 14772 kWh which has decreased by 2.2 percent compared with the previous year. The share of electricity consumption in this sector was about 9.3 percent of total consumption.

3. The Agriculture Sector

The number of agricultural sector subscribers grew by 4.4 percent compared to the previous year to 464 thousand subscribers, and electricity consumption increased by 1.9 percent to 38764 million kWh. In 2019, the average consumption of each subscriber in the agricultural sector was 83593 kWh which has decreased by 2.4 percent compared with the previous year. The share of energy consumption in this sector was equal to 14.1 percent of total consumption.

4. The Industrial Sector

The number of industrial sector subscribers increased by 3.6 percent to 255thousand subscribers compared to previous year and energy consumption increased by 9.6 percent to 97081 million kWh. The average consumption of each industrial subscriber is 380996 kWh, which represents about 5.8 percent increase. The share of consumption of this sector was 35.3 percent which has the largest share compared to other sectors.

5. The Commercial Sector (Other Sectors)

Sectors such as stores and companies and so on are categorized in this group. In 2019, the number of this sector subscribers increased by 4 percent to 4766 thousand subscribers compared to previous year and energy consumption increased by 6.1 percent to 20143 million kWh. The average consumption of each subscriber in this sector is 4426 kWh, which represents 2 percent increase compared to 2018. The share of consumption of this sector was 7.3 percent of total consumption. This sector mainly includes commercial subscribers.

Road Lighting

Road lighting is for the sake of citizens' security and welfare which coexists with the grid peak load from sunset to sunrise. In other words, reducing its effect on peak load through consumption time transfer is not adequate and energy can be saved in this sector only by increasing the efficiency of lighting lamps and meeting the road lighting standards.

In 2019, the electricity consumption of road lighting increased to 5017 million kWh which shows an increase of 0.6 percent compared to the previous year. The share of this sector consumption has been about 1.8 percent of total consumption. One of the problems of the electric industry in recent years is the unauthorized use of the electric grid which often uses heavy electrical appliances and in addition to the robbery from the power grid; it also causes serious damage to the grid. Fortunately, by eliminating a part of unauthorized subscriptions, the unauthorized consumption has decreased. It should be noted that a part of the losses in the electric power distribution network is because of unauthorized subscription which should be treated as an undesirable phenomenon by imposing the necessary rules.

Load and Energy Balancing

In 2019, the simultaneous power generation at the load peak was 57017 MW. The total of this amount is 85.3 percent of the country's maximum modified consumption requirement. Also, the maximum supplied load simultaneous with the maximum consumption requirement was 57104 MW.

In this year, the maximum modified simultaneous consumption requirement has increased by 1 percent. In 2019, the country's power plants gross generation including governmental (belonging to Ministry of Energy) and non-governmental power plants was 326431 million kWh. Specific production with reduction of power plants domestic consumption was 8871 million kWh of gross generation, equal to 31756 million kW. Import and export of electrical energy was 1341 and 8206 million kWh, respectively. The maximum daily required energy was 1234 million kWh.

Generation load factor and power plant operation factor were 65.4 and 51.4 percent in 2019. Energy losses in transmission and sub-transmission networks was 2.76 and in distribution network was 9.76 percent respectively and total losses of country's electric power network was 10.32 percent. Figure 37 demonstrates electric power network losses and Fig. 38 shows annual growth trend of generated power, supplied power and revised consumption need.

Fig. (28): Diagram of Different Sectors' Share in Electricity Energy Consumption

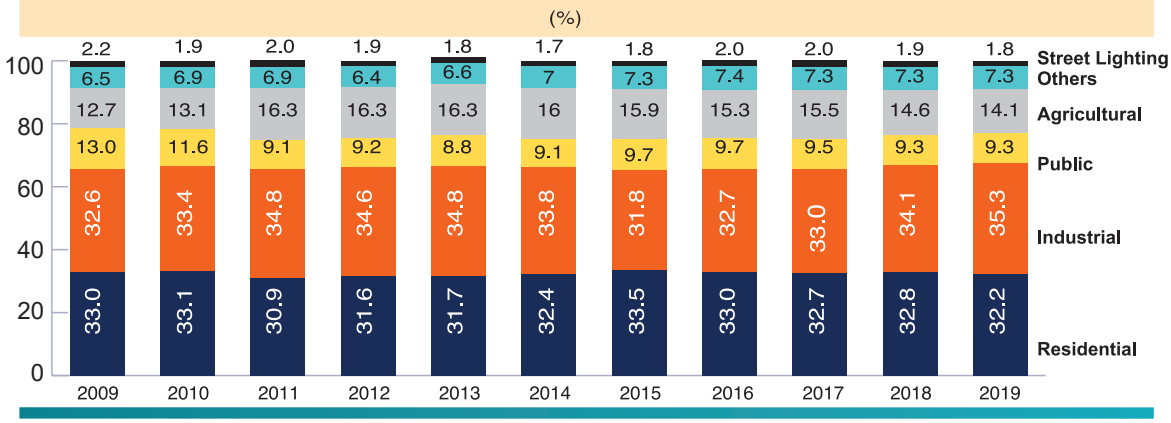


Fig. (29): Diagram of Trend of Bulk Power System Loss Changing

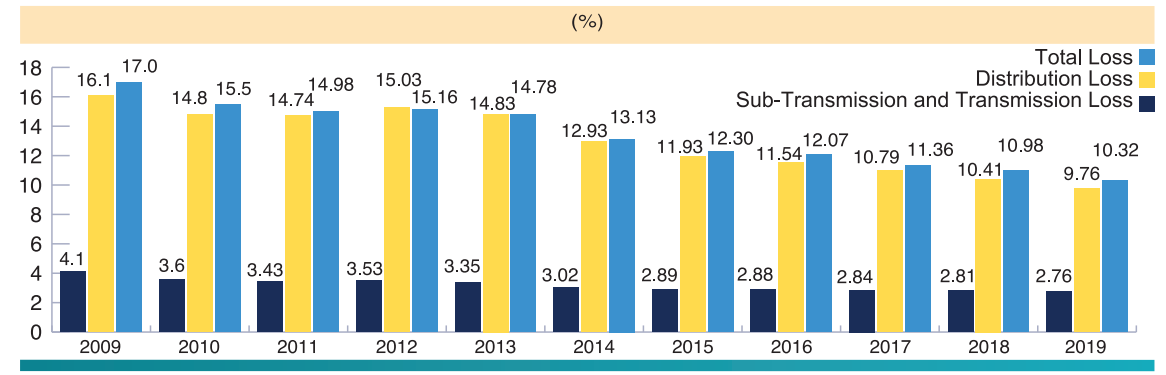
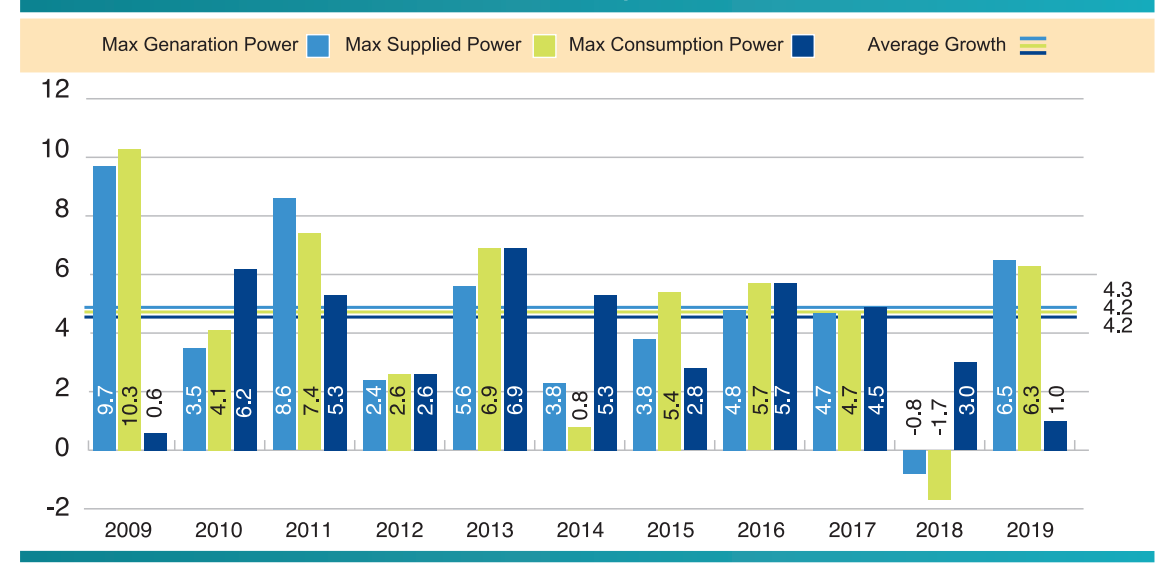


Fig. (30): Diagram of Annual Growth Trend of Power Generation, Supplied Power and Revised Consumption Need



Power System Management and Leadership

"Iran Grid Management Company"

Mission and Objectives of IGMC:

- Reliability management, optimum utilization of generation and transmission resources in such a way to ensure safety, security and reliability of power system operation and continuous dependable service and supply of power & energy at economically acceptable cost, for all consumers anywhere in the network.
- Providing open access to the electricity network for all applicants of state run or private sectors with the aim of transacting or/and transmitting electricity
- Making provisions for fair competition and competitive transactions by establishing, operating, and developing electricity market and power exchange
- Adopting effective policies and operating necessary measures in order to ensure power supply, expanding the participation of private sectors, by developing competitive environment in power generation and distribution within the framework of the policies set by the Ministry of Energy

1. National Grid Dispatching (NGD) Deputy

The National Grid Dispatching (NGD) deputy is responsible for preserving the stability and security of Iran's national grid, ensuring the continued supply of the required electricity for consumers and optimal operation of Iran's power system based on electricity market regulations through planning, monitoring and managing the generation and transmission network.

These duties are performed in three categories that are detailed in the following:

- Operational Support and Planning:
  - Continuously evaluating the stability and security of Iran's national grid
  - Analyzing the bottlenecks of the national grid and issuing special operating instructions in order to support the operating and security assessment of the grid
- Operation and System Control:
  - National grid monitoring and dispatching according to "Operations Procedures" and supervision on the accurate application of these procedures
  - Evaluating the real-time operating point of the national grid regarding to the security and reliability level and implementing the required control actions in order to preserve the normal operational condition
- Engineering and Supervision:
  - Engineering and support services to ensure reliability, availability and functionality of SCADA/EMS facilities, dedicated telemetering and telecommunication services at National Load Dispatch Center
  - Supporting the National Dispatching required communication, software and hardware

Functional Model

Backup Dispatching (Zanjan):
In normal condition, some parts of the dispatching activities are performed in BSCC based on the previous coordination with SCC. A backup operation starts in BSCC whenever the dispatching activities cannot be fulfilled in SCC due to any reasons.

2. Planning & Supervising Grid Security Deputy

In line with the main objectives of IGMC, the main processes of this deputy are as follows:

- Developing the strategies and strategic planning of Iran Grid Management Company with regard to grid security
- Preparing and developing the road map of electric power Industry generation and transmission network protection systems
- Expanding and upgrading the smart systems of transmission network with the aid of phasor systems
- Supervision on preparing and developing different required statistics of the electric power industry for various segments

Research and Technology Development

- Regular review of the present or revised instructions based on the company's long term plan
- Developing and updating research road map annually

Planning & Grid Security Studies

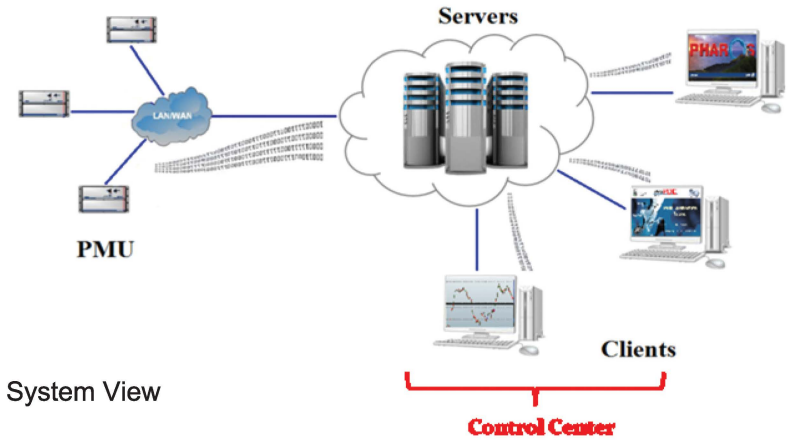
- Receiving the grid equipment information from the regional transmission companies, and power plants equipment from the country's power plants. Verifying and inserting the info in the grid equipment database PGDS, and modeling it in the studies software and updating present and future power grid map

Grid Studies and protection

- Receiving grid disturbances investigation reports from Regional Transmission Companies and National Dispatching, analyzing transmission disturbances, providing necessary reports and solutions, and pursuing implementation of the proposed solutions in order to prevent similar disturbances repetition

Wide area systems studies & monitoring

- IGMC's WAMS is based on high- frequency – sampled (20ms) synchro-phasors of voltage and current from phasor monitoring units (PMUs)
- PMU receives analog inputs from PTs, and CTs, samples the values and calculates 20 ms Phasors. The resulting phasors are synchronized via GPS signal



System View

3. Electricity Market Deputy

Electricity market is an evolving process. Power system requirements, preserving the competitiveness of the electricity trades, and energy policies cause to have a long term scope in the design of the market mechanisms. In IEM the main future steps is as follows:

- Inclusion of the real time market to the IEM
- Establishment of the Regional electricity market under the supervisory of (Economic Cooperation Organization) ECO
- Opening of the ancillary services competitive market

The Day-Ahead Market

In the day ahead market an auction is established for the generation companies (GENCOs) with pay as bid mechanism. GENCOs submit their bids the day before delivery of power. The sellers' bids consist of the prices and the quantities. The customers only submit their quantity of demand. As a matter of fact, this mechanism is a single sided auction for the sellers. Market operator clears the market based on the submitted bids of GENCOs and the buyers' demand.

Bilateral contracts

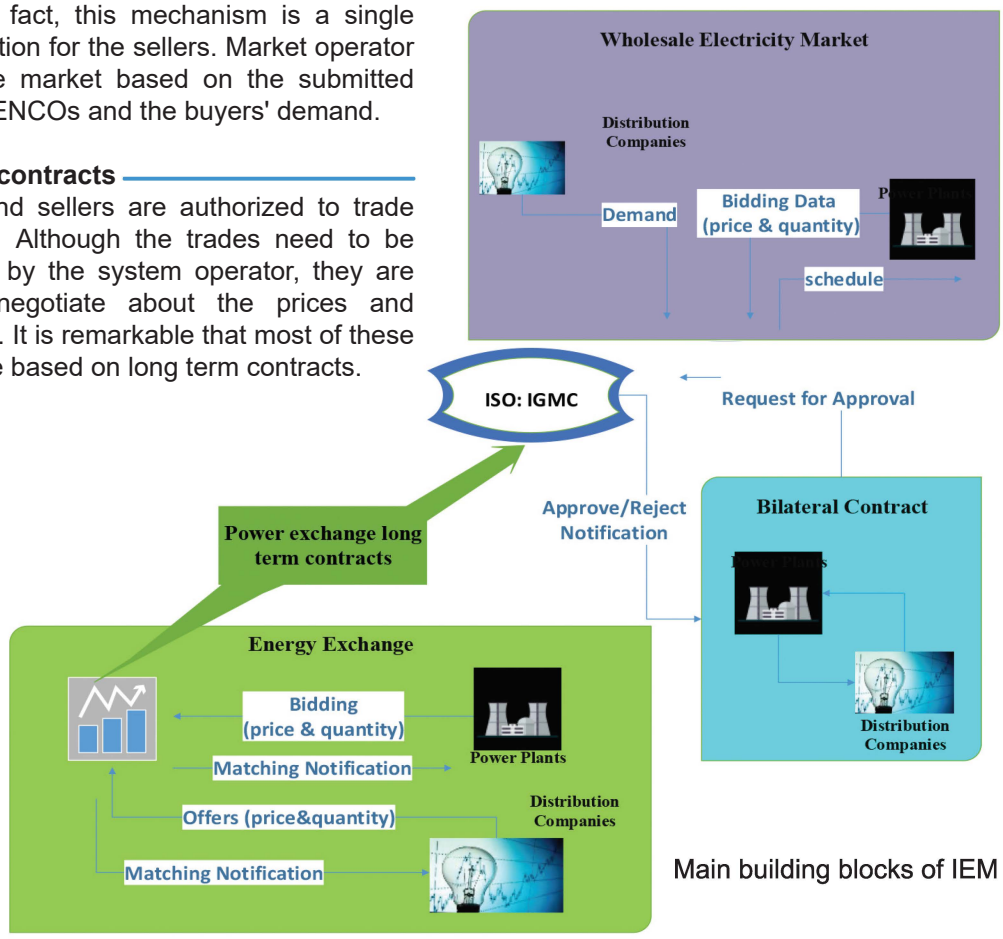
Buyers and sellers are authorized to trade bilaterally. Although the trades need to be approved by the system operator, they are free to negotiate about the prices and quantities. It is remarkable that most of these trades are based on long term contracts.

Energy exchange

In the energy exchange, the trades are categorized as the future contracts leading to power delivery. The buyer and sellers match their bids and offers for a certain quantity of power and the delivery of power will be in the time to come. They are free to make decisions about the prices and there will not be an intervention on their decisions. It should be noted that only the private GENCOs have the authority to participate in the energy exchange and sell their power.

The Customers and producers

Currently there are 39 Distribution Companies who are authorized to participate in the wholesale electricity market. 16 Regional electricity companies which principally act as transmission companies (Transcos), also take the role of energy purchaser in the wholesale electricity market. Tavanir also purchases electricity in the wholesale electricity market for exporting purposes.



Main building blocks of IEM

4. Communication and Technical Support Deputy

Communication and Technical Support as an infrastructural deputy holds two main responsibilities:

- Providing secure and robust communication services between various network components in the power industry
- Providing energy information services of Iran national grid

This deputy works with the assistance of experts in the field of information and communication technology (ICT) and electrical energy metering based on the above mentioned missions as follows:

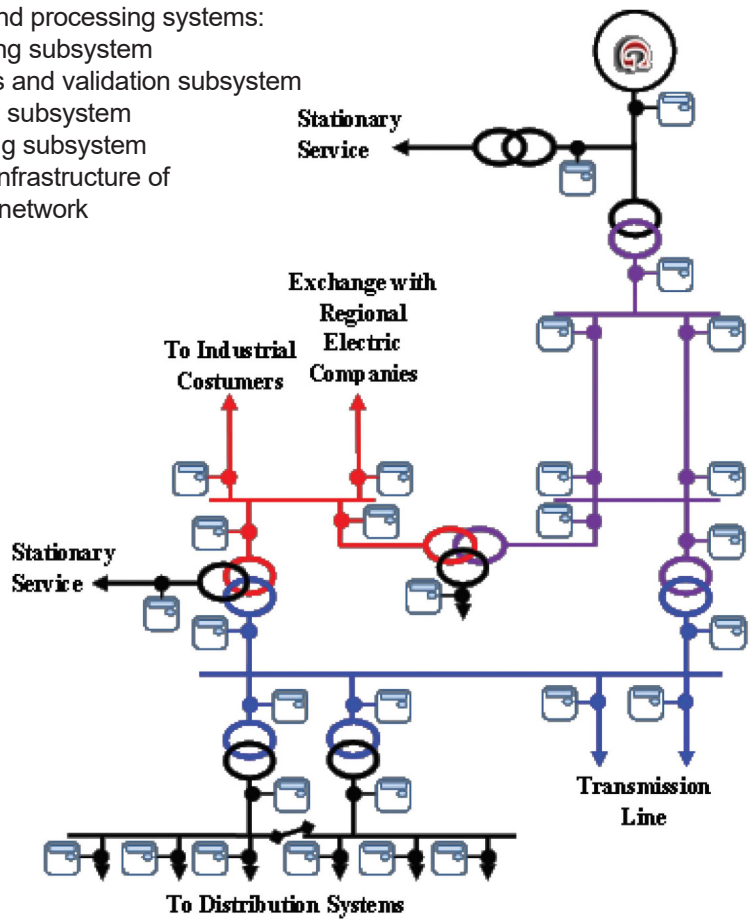
Information and Communication Technology (ICT)

The main responsibility of communication and technical support deputy is providing and maintaining of secure and robust information services in the power industry infrastructure network.

Electrical Energy Metering

Metering the accurate value of energy exchange is one of the vital issues in power system operation and planning, and also power market billing. The main responsibility of the electrical energy metering bureau is planning, managing and supervising the operation of the energy metering systems in Iran power system. The main components of energy metering system can be classified as follows:

- Energy measuring equipment
- Data gathering and processing systems:
  - -Data gathering subsystem
  - -Data process and validation subsystem
  - -Data storage subsystem
  - -Data reporting subsystem
- Communication infrastructure of energy metering network



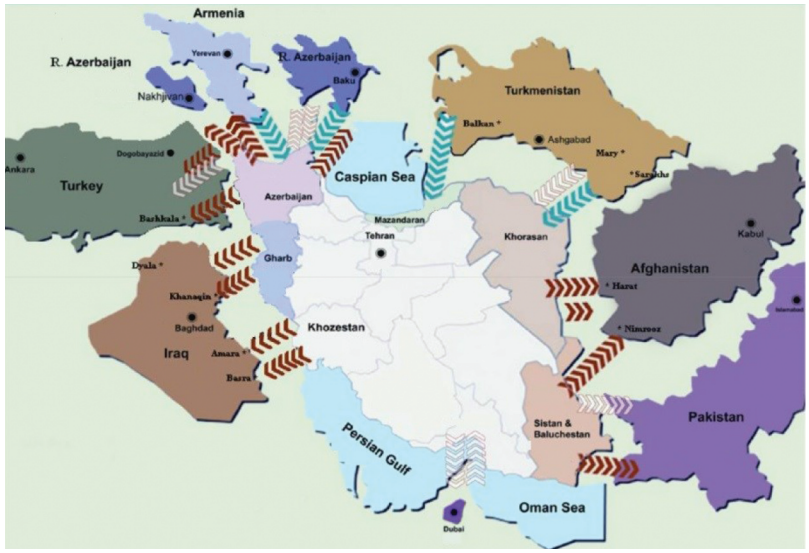
Typical overview of Iran national grid metering points

5. Cross- border Electricity Exchange

In line with the policies adopted by Ministry of Energy of I.R.Iran to exchange Electric energy with neighboring countries, Iran Grid Management Company (IGMC) has established Cross-border Electricity Exchange Office aiming at implementing the Sale/Purchase Contracts, supervising the operation of interconnection lines, monitoring the electricity transactions, and observing their technical and economic aspects.

Significant Objectives and Duties:

- Monitoring the operation of interconnection lines and electricity transactions constantly
- Investigating the technical and economic potential of neighboring countries to evaluate the optimized condition of import/export/exchange/ transit of Electric Energy as well as carrying the feasibility studies
- Conducting the negotiations, preparing the draft and, engaging in concluding of import/export/exchange/ transit Contracts
- Planning on development of cross-border trade by expansion of transmission capacity of interconnection lines and synchronization of Iran's power grid with neighboring countries power grids
- Concluding the Connection Agreements in addition to Sale/Purchase Contracts provided that connection to neighboring countries' power grids will not disturb the internal grid.
- Settling the technical issues related to in-between Contracts daily and permanently (put the lines on/out of operation)
- Planning on seasonal regimes of power exchange based on in-between Contracts
- Measuring, monitoring and balancing of import /export of Electric Energy, issuing of invoices and observing the final revision of sale/purchase/ exchange/ transit of Electric Energy
- Checking the validity of correspondence energy meters in Iran and neighboring countries through regular testing, sealing and, inspection
- Settling of any dispute may arise between parties, including issues related to monthly invoices and obtaining the consent of other party.
- Seeking the receipt of receivables and paying the outstanding debts
- Providing information such as OPEC oil price, currency exchange rate, etc. from other organizations to estimate the Electric Energy price
- Membership in technical-economic operation committees aiming at construction and development of lines and supervising the related committees in the field of export /import of Electric Energy



Electric power transmission lines between Iran and neighboring countries

Human Resources

Human Resources

Human resources are the most valuable and primary agents in production, economic growth and prosperity, social, cultural and service of any country and the more the number of educated, committed and expert people in the community the more is the development and success of that nation in the world.

No organization without skilled and entrepreneurial personnel can survive for a long time. Especially in today's world where scientific and technological progress has grown rapidly and most successful countries are struggling to overcome others by attracting more customers and delivering services with higher quality and quantity.

In our country, due to the implementation of Article 44 of the Constitution and the issue of privatization, it is necessary that the employed person, in addition to having high knowledge, is a customer and market attracter. Especially in the complex industry of electricity, there is a need for valuable human resources, and since technological progress is very fast, it is imperative that the knowledge and expertise of the workers of this sensitive industry are constantly upgraded.

In Iran electric power industry, it has always been tried to use capable managers having systems thinking. Systems thinking or systems management is a way of managing a company which considers the phenomena roots and causes in directing structure of that company.

Ideal, Missions, Strategies and Policies of Tavanir Co. Human Resources Management

Ideal: Educating knowledge oriented and customer oriented human resources.

Mission: Policy making and facilitation of supply and development of human resources and providing services to senior managers of the electric power industry for the development of human resources of the electric power industry of the country.

Values: Maximizing the use of science, consulting with subsidiary companies and other experts, strategic and systematic performance, maintaining employee dignity, serving employees and customers, law enforcement, justice in administrative behavior and public communication, respect for differences between Individuals, excitement, risk taking, innovation and responsibility.

Strategy: Effective interaction with upstream levels, making activities scientific and creating scientific attitude towards management activities in electric power industry, expediting and accelerating implementation of human resources plans, guiding and directing electric power industry in the areas of human resources development and strengthening the human resources potentials of the management.

Measures Taken in the Field of Planning and Providing Human Resources

- Reviewing and approval of requests of employee numbers and ID for employees of Tavanir Co and subsidiary companies in Iran Employee System
- Carrying out further measures related to the organization of the employees of transmission and sub-transmission substations
- Updating the human resources plan document of Tavanir Co and its subsidiary companies
- Attracting and employing more than 650 employees in subsidiary companies through 201818/10/ employment exam

Measures Taken in the Field of Human Resource Development and Training

- Designing a model to evaluate the talent management plan and the manager supply plan
- Designing and obtaining training codes for new courses required by electric power industry employees
- Implementation of a pilot for the development of competency profiles for specific jobs of the electric power industry (in the field of distribution operation, repairs and maintenance of transmission sector and sales and after-sales subscribers services.)

Measures Taken in the Field of Welfare and Motivation

- Conducting health insurance survey at the subsidiary companies and analyzing and publishing the results for the use of subsidiary companies
- Supervising the proper implementation of comprehensive insurance contracts of ensuring and protecting the health of employees, life and accident insurances and employer liability, life and accident insurance of government employees, fire insurance for homes and offices, car body and third party

insurances and medical assistance instructions at the subsidiary companies level and providing the proposal to upgrade its improvable fields to the Ministry of Energy and cooperation and continuous interaction in the preparation and implementation of personal and property insurance contracts

Measures Taken in the Field of Payment System

- Preparation and communication of accommodation instructions for sub-transmission and transmission substations employees with job classification and evaluation plan of subsidiary companies
- Notification and implementation of circular of the 50% (30%) increase in the points of chapter 10 of the Governmental Services Management Law in subsidiary companies and Tavanir Co
- Reviewing and approval of the allocation list of managerial and supervision positions of groups 18 and higher of electric power distribution companies
- Reviewing, approval and ranking of expert and senior levels of subsidiary companies and Tavanir Co according to the relevant criteria
- Notification and implementation of the circular of determining the salaries and benefits of specific-job employees of subsidiary companies and Tavanir Co equivalent to 80% of the equivalent contractual employees

Fig. (31): Diagram of Separation of the Power Industry Personnel by Their Education in 2019

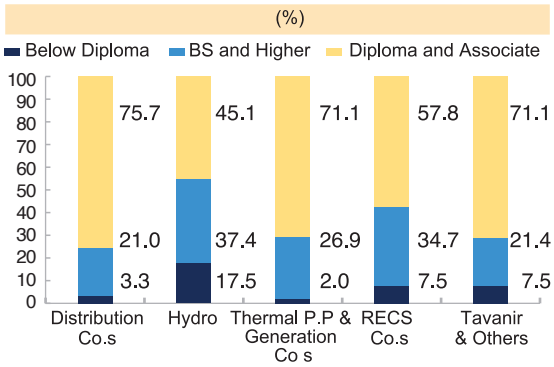


Fig. (32): Diagram of Age Distribution of the Personnel in 2019

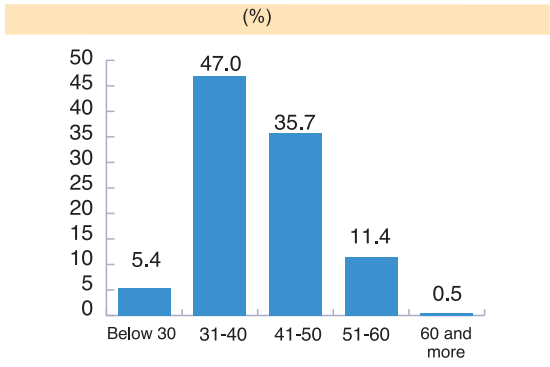


Fig. (33): Diagram of Variations in the number of personnel from 2009 - 2019

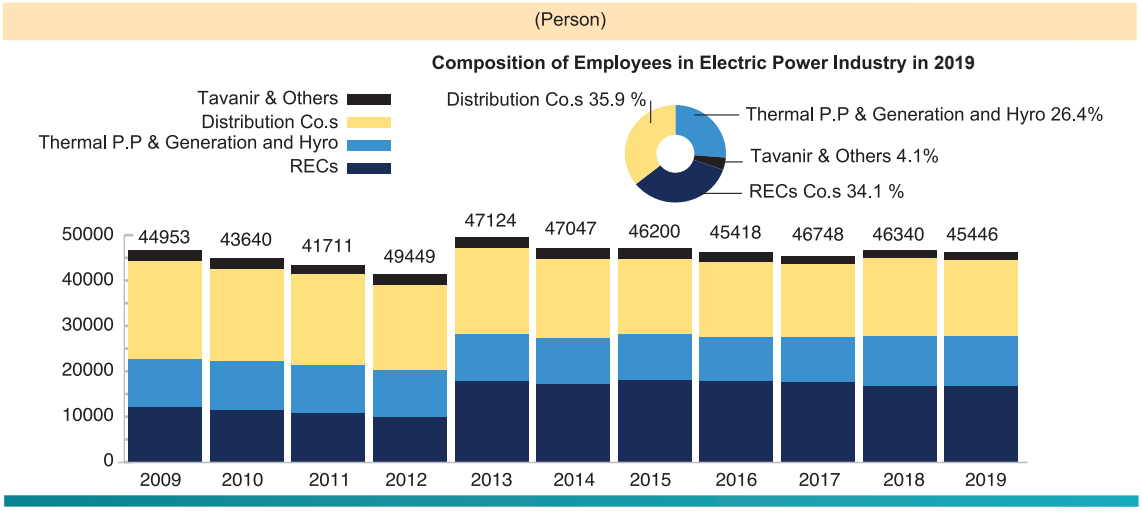
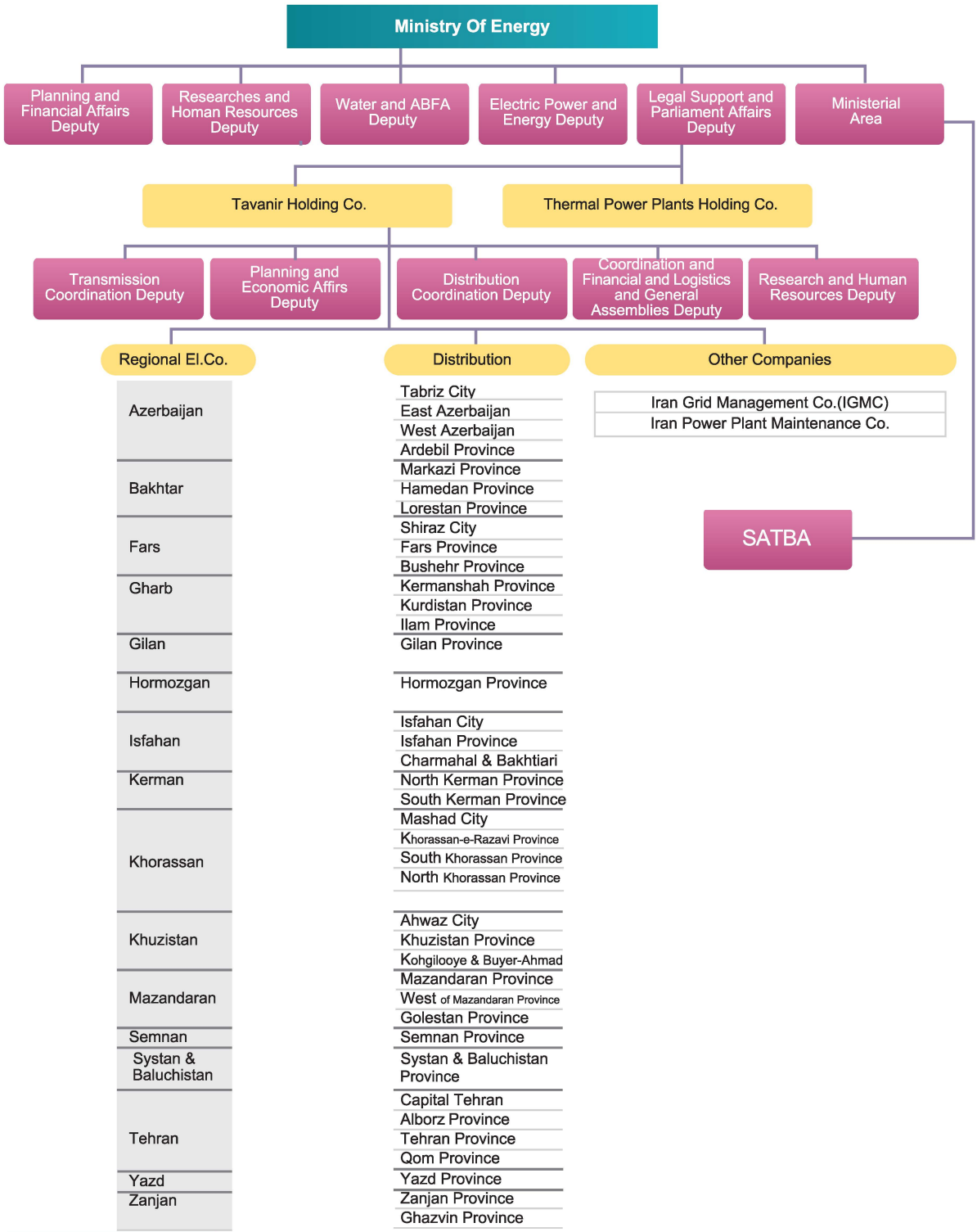


Fig. (34): Diagram of Organizational Chart of Ministry of Energy (MOE); Electric Power Affairs



Improving Productivity

A. Performance Report of Organizational Excellence Sector, Strategic Management, and Performance Management in Electric Power Industry in 2019

The Most Important Activities in the Field of Organizational Excellence Development in Tavanir Co and Subsidiary Companies

- Reviewing, integrating and prioritizing of improvement projects in Tavanir Co in 3 year comprehensive program
- Preparing and formulating the improvement project control form for effective control of the planning and implementation of projects in Tavanir Co
- Planning and facilitating the implementation of self-assessment based on organizational excellence model in electric power industry
- Facilitating formation and distributing the improvement knowledge among Tavanir Co subsidiary companies
- Planning and supervision of management systems of electric power industry

The Most Important Activities in the field of Strategic Management

- Supporting the development of organizational excellence in electric power industry including self-assessment and defined improvement projects in subsidiary companies and Tavanir Co
- Planning, supervising, and performing related activities to prepare a comprehensive strategic document for Tavanir Co including the codification and finalization of objectives, key performance indicators (KPIs) and strategies at the high level of Tavanir Co and at the level of professional units and the development of operational plans including:
- Prioritization and weighting of key performance indicators (KPIs)
- Preparation and compilation of strategic information and executive plans based on the BSC model
- Determining the levels of importance of key performance indicators (KPIs) at the high level of Tavanir Co
- Reviewing the proposed strategies map of high level of Tavanir Co
- Preparing the Key Performance Indicators (KPIs) of Tavanir Co and each of the professional fields
- Planning for the implementation of the formulated strategies in electric power industry and its control and monitoring at Tavanir Co and its subsidiary companies in order to achieve the strategic goals and vision set out for the Horizon 1404

The Most Important Activities in the Field of Administrative System Improvement Comprehensive Program

- Planning, reviewing and analyzing the administrative system improvement comprehensive plan in the management development steering commission of Tavanir Co and its five sub-committees and communicating it at the level of Tavanir Co and its subsidiary companies
- Development of administrative system improvement plan of reforming electric power industry in accordance with the country's roadmap and administrative system improvement comprehensive plan within the framework of strategic policies and programs of Ministry of Energy
- Planning and implementing the approvals of management development steering council of Ministry of Energy and communicating the approvals to the executive units of the specialized parent companies and subsidiary companies
- Monitoring the progress of electric power industry administrative system improvement plan

The Most Important Activities in the Field of Management Systems

- Leading the development of electric power industry required management systems in order to establish, maintain, update and develop management systems
- Developing and publishing the database of establishment, maintenance, updating and development of management systems of subsidiary companies
- Supervising the establishment, maintenance, updating and development of the management systems of subsidiary companies

Development of Kaizen and 5S Activities in Electric Power Industry

- Cooperation with the Association of Electric Power Distribution Companies in the form of membership in the continuous improvement commission
- Planning the required trainings for subsidiary companies in Kaizen and 5S areas
- Planning the required actions for improvement of electric power distribution companies through the continuous improvement commission

The most important programs that will be implemented in 2020 in the fields of organizational excellence, administrative system improvement, management systems and strategic management in electric power industry

- Improving the effectiveness of Tavanir Co and its subsidiary companies management development commission and related committees and approvals and how to do it
- Organizing the management development steering committee and the five committees and working groups of each committee at the level of Tavanir Co and its subsidiary companies in terms of composition and number of members, number of committees and working groups, etc.
- Receiving performance reports and programs of the five committees and working groups of each committee in 2019
- Surveying subsidiary companies on the effects and results of the establishment of management systems and organizational excellence and alternative methods, the establishment of an administrative improvement system, strategic planning to update relevant policies
- Reviewing and updating the strategic plan of electric power industry for the Horizon 2025 and executive plans based on the BSC model
- Reviewing the improvement projects of subsidiary companies based on Tavanir communicated policies and allocation of required budgets of companies and controlling the progress of improvement projects
- Planning and monitoring the establishment, maintenance and updating and upgrading of management systems of electric power industry

B. Performance Report of Productivity Sector at Tavanir Co and its subsidiary companies in 2019

The Most Important Activities of Productivity Sector at Tavanir Co and its subsidiary companies

- Preparing and updating the productivity indicators measurement in accordance with the guidelines for measuring productivity indicators from 2011 to 2018 for subsidiary companies and Tavanir Co in a combined manner
- Preparing analytical reports of productivity indicators in order to identify external and internal influential factors
- Executing the establishment of productivity cycle by identifying the steps to improve productivity

Activities Carried Out in the Performance Evaluation of Tavanir Co and Subsidiary Companies (Shahid Rajayi Festival)

- Taking part in the performance evaluation process of 2018 (2019 Shahid Rajayi Festival) at national and provincial levels

The Most Important Activities Carried Out in order to Develop the Proposals System of Tavanir Co and Its Subsidiary Companies

- Sending 16 proposal calls and receiving 284 proposals from proposal calls
- Receiving 1732 proposals in 2019
- 243 approved proposals
- 168 implemented proposals

C. Performance Report in the Field of Organizational Structure in Tavanir Company and Its Subsidiary Companies in 2019

The most important activities performed in the field of organizational structure in Tavanir Company and its subsidiary companies:

- Designing and preparing the higher structure of Tavanir Co with the necessary statistical and justification reports

The most important programs that will be implemented in 2020 in the field of organizational structure in electric power industry:

- Approval of the Great organization of Tavanir Co and regional electric power companies by the Ministry of Energy (MOE) and Administrative and Recruitment Organization (ARO)
- Preparing and planning the delegation of authority from Tavanir Co to its subsidiary companies

Information Technology and Statistic

Preface

Serving the customers has been the most important goal in the country's electric power industry. Information flow is also one of the most important and efficient tools in an organization to serve its customers. If an organization wants to have correct, up-to-date, and accurate information and use it in decision making, it must pay attention to information systems as well as improving and developing them.

In this regard, Information Technology (IT), Communications and Statistics office of Tavanir Co corresponding to its sovereign duties through policy making, planning, organizing, guiding and supervising, development of standards and guidelines, communication and cooperation with universities, research and academic centers in the country as well as IT departments of governmental companies provide the necessary means for integrating information and communications infrastructures, facilitating the flow of information, implementing the e-government, deploying an efficient information network in electric power industry, proposing on time, correct and precise statistics provides required infrastructures in order to grid smartization of country's electric power industry in accordance with modern technologies.

Vision

Vision of Information Technology, Communications and Statistics Office of Tavanir Co to develop Information and communications technology (ICT) in electric power industry is:

"Obtaining the global level for electric power industry in utilizing information technology and communications and realization of smart grid in the following ideal dimensions"

In 2019, the most important strategies of the office for achieving the vision of ICT development in electric electricity industry were:

1. Standardization of management systems (in three aspects of management, services and security), ICT infrastructure and ICT applications (providing information systems)
2. Strengthening IT governance through the deployment of expert systems to increase the speed and accuracy of decision making in Tavanir Co
3. Strengthening R&D role in the office programs with an emphasis on the optimal use of the technical and research capacity of scientific centers, universities and knowledge based companies
4. Focusing on the development of an electronic organization in electric power industry with an emphasis on designing and implementing comprehensive and integrated organizational solutions, development of electronic systems and channels with stakeholders in pursuit of e-government, and the establishment of the comprehensive portal of electric power industry
5. Organizing the registered statistics system in electric power industry in order to obtain correct, accurate, and up to date statistics
6. Development of knowledge management system in electric power industry
7. Strengthening and developing data and information exchange infrastructure of communications networks
8. Business intelligence based on data science and advanced analysis

The activities of Information Technology, Communications and Statistics Office in order to implement the aforementioned strategies in 2019 are as follows:

Policy Making and Planning

1. Preparing a three-year E-government development plan and electric power industry smartization plan and tracking the subsidiary companies tasks in this regard as well as pursuing subsidiary companies troubleshooting related to governance and regulatory companies and preparing required reports on the plan.
2. Identification and completion of the process flowchart of providing electronic services of regional electric power companies and preparation of uniform and integrated software for providing the aforementioned services to the beneficiaries.

3. Developing or updating major ICT E-government policies and plans
4. Guiding and supervising professional superior supervision committees and task forces

- **Credits and Budget of Electric Power Industry IT in Subsidiary Companies**

Collection and classification of requested credit documents of subsidiary companies and also the performance of ICT projects

- **Electronic Services in Electric Power Industry**

1. Updating the operational plan for the development of E-government and smartization of the electric power industry from 2018 to 2025 based on the E-government development roadmap approved by the High Council of Information Technology and monitoring its implementation.
2. Evaluation of subsidiary companies in the field of administrative health of Shahid Rajayi Festival 2018
3. Providing softwares for providing remote services at regional electric power companies and electric power distribution companies
4. Exchanging a memorandum of understanding with the Ministry of Industry, Mine & Trade (MIMT) for cooperation especially in Cryptocurrencies and electric power towers limits inquiry services

- **Standardization and Integration**

1. Modification and finalization of services description of governance standards model and electric power industry IT services management and pursuing the contracting process based on ITIL and COBIT
2. Finalizing, communicating and updating the corporate architecture reference model of regional electric power companies and communicating them to subsidiary companies

- **Audit, Control, Evaluation, and Supervision**

1. Evaluation of all regional electric power companies based on the checklist of comprehensive IT performance evaluation system of Tavanir subsidiary companies
2. Carrying out remote auditing of the website/portal standardization of the subsidiary companies based on the previously announced criteria and announcing the results to the companies.
3. Superior supervising of the implementation of adaptive organizational architecture based on the reference model and preparing a detailed organizational architecture plan for Tehran and Mazandaran regional electric power companies

- **Research and Development in Information Technology**

One of the key strategies of Tavanir Co IT office is to strengthen the role of technology research and development in office plans by emphasizing the optimal use of technical and research capacity of scientific centers, universities and knowledge-based companies. In this regard in 2019, the following measures were taken for the following research projects:

- **Geographic Information System (GIS) of Transmission and Sub-Transmission Networks and Spatial Data Infrastructure (SDI)**

Among all the important activities in this area is the formation of electric power industry GIS guiding committee in transmission and sub-transmission sectors which has been facilitating and coordinating activities related to Geographic Information System (GIS) in Tavanir Co and its subsidiary companies for 10 years. The major activities of the committee in 2019 include:

1. Examining the existing obstacles in the field of executing and updating of GIS in regional electric power companies and providing the necessary solutions
2. Discussing and evaluating the synchronization of PGDS database information and electric power industry Spatial Data Infrastructure (SDI) information
3. Establishment of electric power industry WEBGIS in Tavanir Co and training it to the transmission technical offices and network planning development managers and experts

- **Development and Creation of Information Systems at Tavanir Co**

1. Preparing and establishing a spatial data system of land acquisition
2. Supervising the development and support of more than 40 application systems in various fields

- **Website Domain and Portal**

1. Collection and analysis of subsidiary companies websites specifications
2. Obtaining average score of 32.35 out of 35 by subsidiary companies in performance evaluation

of Shahid Rajayi 2018 Festival in the field of website standardization

- **Specific Data Network of Electric Power Industry**

1. Development of Tavanir Co and subsidiary companies specific data network in collaboration with the academic centers and increasing the operation of this network
2. Connecting a part of electric power distribution companies networks to the electric power industry data network

- **Technical Support of Infrastructures, Data Security, Internal and Broadband Network - Data Center Development, Maintenance , and Support**

1. Development, maintenance and support of utilized infrastructure databases, hardware and software
2. Superior supervision in the field of ICT security in subsidiary companies and policy making and management of Tavanir Co in this area
3. Supporting and developing of data center services such as Video Conference, Voice over IP (VOIP) phone system, and IP video telephone in the context of broadband network communications of electric power industry between headquarter and subsidiary companies
4. Executing and establishment of video conferencing service between Tavanir Co and subsidiary companies and holding remote meetings

Information and Statistics Deputy

Attention to the information and statistics and establishment of proper organization based on scientific principles and following the latest related technologies and correct and timely information and statistics to reply to information needs of electric power industry managers in various levels can be efficient and useful to solve the electric power industry problems, capital losses and optimal planning. Since the statistics information produced in statistics group of Tavanir Co is the only official reference for decision makers and macro planning managers of electric power industry, its importance is significant.
Information and Statistics group activities of Tavanir Co are included in four areas as follows:

1. Publication Services including:

Detailed statistical reports of electric power industry and also colorful and analytical reports of electric power industry in two languages of Persian and English (totally 11 Volumes) and weekly bulletin. These reports have 790 statistical and information items in generation, transmission, distribution and human resources sectors of electric power industry and all of the items are defined.

2. Information Technology Services including:

Statistics website with the web address: http://amar.tavanir.org.ir including all publications and statistical reports archives for 52 years sorted in the website of statistics group.

3. Services of responding to inner and outer organization information and statistics needs

This service is performed based on the case for conferences, occasions and interviews.

4. Creating Web-Based Electric Power Industry Information and Statistics Collection Integrated System

This system has been developed to collect integratedly all information and statistics from subsidiary companies and publishing them.

5. Deployment of Management Dashboard of Detailed Statistics Reports and Weekly Bulletin on Tavanir Co Superior Managers' Mobile Phones

6. Gathering Statistics from More Than 60 Statistical Units in Subsidiary Companies, Related Companies, Thermal Power Plant Companies, Water Companies, and Water Resources Companies in order to Publish Official Electric Power Industry Statistics through the Statistical Website

7. Information Management including:

- Organizing data and creating an index at the end of each report
- Statistical coordination with regional electric power companies and Ministry of Energy (MOE) before the publication of the report
- Decreasing the time of proposing statistical reports and decreasing errors of data exchange
- Upgrading the quality dimensions of statistics announced by Statistics International Standards Organization including: correctness, accuracy, updating and scheduling in the proposed statistics through questionnaire from the users of statistical reports and annual needs assessment. The survey on the use of statistics in the management of electric power industry, which was carried out to upgrade the official electric power industry reports in 2004, 2005, 2006, 2013, and 2017 is also planned to be implemented for the next year. Poll results are published as reports and are put on amar.tavanir.org website.

- **Needs Assessment:** Inquiring from the users of official statistics of electric power industry in Tavanir Co to propose required statistics and new items.

8. Statistics Management in Companies

A. Preparation of operational plan and performance of companies' statistics

B. Preparation of implementation indicators of statistics management in companies: In order to evaluate the performance of statistics in Shahid Rajayi Festival for the second year and to obtain the highest rank among all government companies

9. Implementation of Fundamental Registered Statistics System:

A. In the National Statistical Program of Iran Article 54 of the five-year program of the fifth and sixth Development Plan of the Islamic Republic of Iran, the registered statistics has been performed and for Transmission data in design and development deputy of a regional electric power company (Mazandaran) is completed and transmission data edition in operation deputy of two other regional electric power companies (Gharb and Hormozgan) is in progress. Recently, the registered statistics project for transmission data in design and development deputy of another regional electric power company (Yazd) has begun.

B. Continuous cooperation with Statistics Committee of Ministry of Energy (MOE) and Statistical Center of Iran to implement the comprehensive registered statistical system of Iran (IRAN STARS)

C. Inquiry on the status of implementation of registered statistics from regional electric power companies and distribution electric power companies to execute the main goal of the country's third national statistics plan (2017 to 2021)

D. Preparation of statistics performance table for ICT and budget for implementation of registered statistics

Document Management Group Activities

1. Preparation and procurement of physical, electrical, and multimedia organization and evanescence of financial documents of electric power industry guidelines and notifying it to subsidiary companies for execution

2. Supervising and consulting of document management group on the physical and electrical organization of documents in subsidiary companies

- Providing attending and non-attending consultation and guidance to subsidiary companies in the execution and implementation of technical, legal, personnel, subscribers, security, tender,

bid, and contract guidelines, and identifying problems and providing appropriate solutions for performing physical and electrical organization, retention, maintenance, servicing activities, documents destroying, and the formation of problem solving sessions as well as transfer of experiences at the office of documents management group, Tavanir Co.

- Supervising the procedure of physical and electrical documents organization such as identifying information fields, document classification, maintenance, document circulation, servicing procedure and documents destroying
- Monitoring through taking activity progress report from subsidiary companies regarding the status of document management and preparation the related table

3. Managing document management software
4. Updating the website of document management group

Library

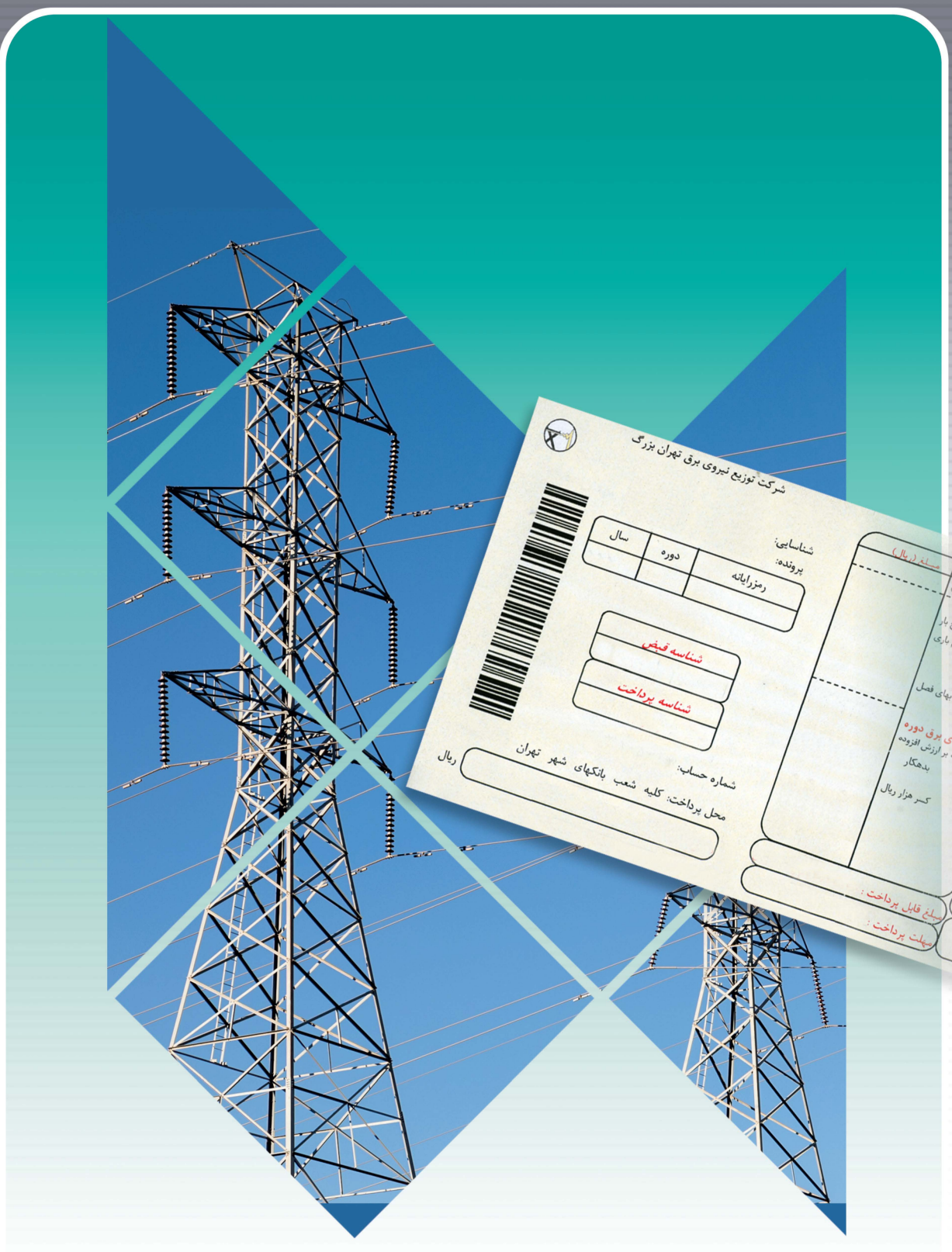
Tavanir Co technical library is one of the richest professional libraries of Iran which has gathered books, periodicals, financial reports, research projects, all of international standards, educational films and required softwares in the subjects of Electronic Engineering, Power Engineering, Mechanical Engineering, Computer Engineering, Civil Engineering and Management as well as other technical and engineering issues. This library in recent years and through utilizing comprehensive system software has generated databases of information resources in Tavanir Co and other important databases inside the country for the searching and availability of all researches, managers and experts of electric power industry and domestic scientific and research institutes.

- Web-based processes
- Holding book fair

Library Databases:

- International standards database
- IEEE articles database
- Persian articles database (Nama Matn)
- Operational softwares database
- Persian and English books database
- Persian and English articles database
- Persian and English Dissertations database
- Persian and English reports and documents database
- Persian documents E-database (Tavanir Co)
- Iran magazines database (www.magiran.com)
- Civilica domestic conferences articles database including domestic conferences articles from 10 years ago up to now (www.civilica.com)
- E-book database

Web address of Tavanir Co professional library: http://library.tavanir.org.ir



Energy Economics

Energy Economics General Issues

From the economic and social viewpoint, energy has a special role in improving human life quality and as a consequence, the issues related to it has a great role in policy making and development plan of different countries including developed and under developing countries. Therefore, energy has great impact on economic, society and environment. As there is a relationship between macroeconomic variables of supply, demand, price and other energy variables, using statistical and econometric techniques, the quantitative values of this relationship is estimated.

According to the aforementioned fundamental role, energy economics in order to provide a modern vision of scientific economics is studying a variety of achievable, experienced and specific species of energy and is trying to present them in the form of economic theories. Today, the driving force of economic activities in most countries it is the energy security and ease of access to it. The importance of this issue is such that the International Energy Agency (IEA) was established in order to provide secure energy supply for members.

Diversification of energy sources in developing countries is not only directly related to energy security supply but also is the infrastructure of developing technology and sustainable development. In fact, energy security is a multifaceted issue that not only highly influences the supply side, but also affects the demand side. Global developments including changes in markets structure, diversity of energies (especially new and renewable energy with minimal environmental costs), variety of goods and consuming facilities, technological changes and etc. have expanded the study fields of energy economics so that more specialized courses within the field of energy economics have formed recently (energy audit and energy management are among them).

Iran is one of the major countries holding major energy resources. Because of the importance of energy, from the viewpoints of export, consumption and economic development, the need for research and development in this field is recognized. Therefore, in order to keep pace with technological developments and studies based on a global level, it is necessary to adopt measures and policies in Iran to pursue this crucial matter which means to invest properly in research and development section.

Electricity Economics

Electricity is one of the best and cleanest types of energies. The importance of the role of electricity in human life is to the extent that it can be used to measure the degree of development of a country, given its amount of consumption, energy intensity, and combination of subscribers and load profiles. In terms of environmental impacts and with the lifetime and rising price of fossil fuels, the tendency to invest in the generation of electricity from non-fossil energy resources has increased so as to find sustainable resources for electricity generation such as nuclear, solar, wind, geothermal, etc. are accelerating.

Electric power industry as a major industry is a non-profit manufacturing company and considering the importance and role of electricity in economic and social activities and considering that the minimum period of construction and operation of a power plant is 3 to 5 years, to maintain and provide optimal electric power services, the electric power industry needs a coherent and dynamic investment.

Electrical Tariffs

Appropriate electricity pricing in addition to direct impact on optimal consumption leads to energy saving and as a consequence decrease of environmental costs. In general, electrical tariffs are categorized based on activity type into five major groups of: residential, public, production (water and agriculture), production (industrial and mineral) and other consumptions. Each of these categories is divided into other sub-categories based on voltage level and contracting power.

Electricity tariffs and their general conditions were increased from the beginning of April 2019 pursuant to Decree No.176327/T/55830/H dated 2019 / 03 / 18 and No. 20205/T/56539/H dated 2019 /05 /14. Consumption tariffs were defined for household tariff subscribers from May 2019. Exceeding this pattern will lead to a further increase in tariffs. On the other hand, households whose monthly electricity consumption was below the defined pattern and have reduced their consumption from May to August compared with the same period of the previous year, were subject to a reduction in the electricity price.
The regions of the country are divided into four tropical zones and one ordinary zone based on the information of Iran Meteorological Organization on the basis of two factors of humidity and average maximum temperature. Tropical zones 1 to 3 have humid and warm weather and tropical zone 4 has dry weather with an average maximum temperature of more than 40 degrees. In the tariff of other consumptions, low voltage subscribers with a power of 30 kW or less in tropical regions will be subject to tropical tariffs considering the climate conditions. In the summer, for the electricity tariffs of all electricity subscribers, except residential subscribers of all areas, the peak factor of the season applies. The peak factor is due to high generation costs in the summer caused by an increase in the temperature of the environment and consequently, decrease of power plants efficiency and increase of generation costs. In order to encourage the manufacturing subscribers (industry and mines) to reduce load and energy in summer peak load, some solutions are considered including industrial cooperation in the annual vacation and repair plan and the operational reserve plan. Agricultural water pump subscribers who have the lowest electricity tariff among the tariffs, in the case of cooperation in reducing electricity consumption during the peak hours between May 15 and August 15, based on the number of no electricity usage days as well as the number of cooperation hours, are rewarded with no electricity bill payment in cooperation period as well as rewards.
It is also possible to select 3 production tariffs (industry and mine) which include only energy costs and temporary reduction of contractual power in order to support the subscribers of the production sector (industry and mine) which do not have a good load factor.

Subsidies of Electrical Energy

At present, despite the implementation of the law on targeted subsidies, most of Iran electricity subscribers take advantage of subsidies. The highest subsidy is related to agricultural sector. In 2019, the electricity cost, considering the subsidized fuel cost (50 Rials), was 1919 Rials/kWh (based on domestic prices) and the average selling price of electricity was 816 Rials/kWh.

Fig. (35): Diagram of Share of Investment in Electric Power Industry

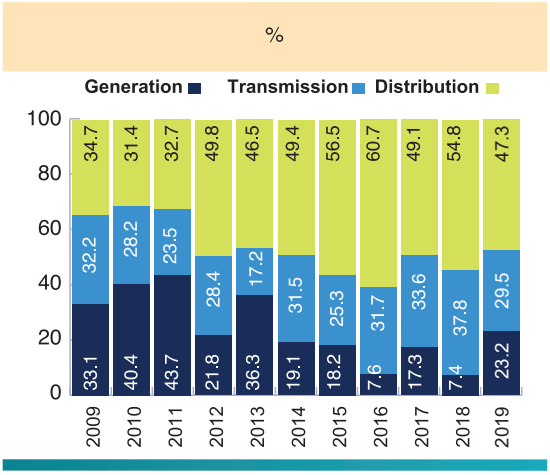
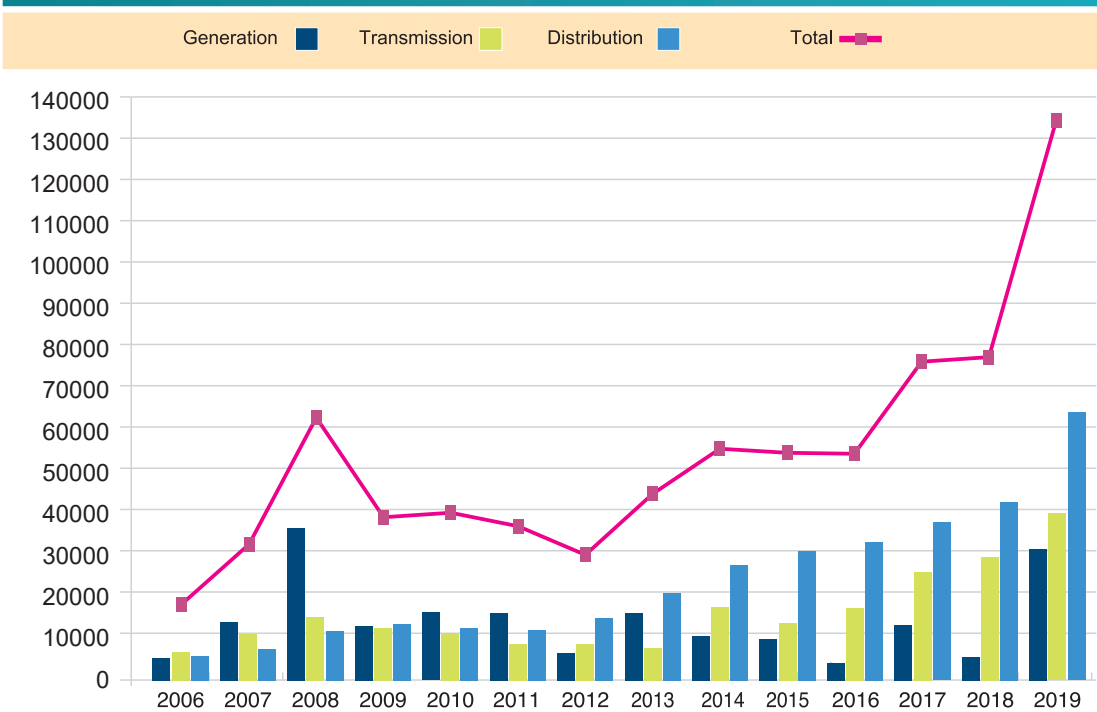


Table 3. The electricity cost and average selling price in 2019.

Consumptions	Electricity cost with subsidized fuel cost (Rials/kWh)	Average selling price (Rials/kWh)
Residential	1919	675
Public		879
Agricultural		258
Industrial		819
Other Consumptions		2605
Total		816

Fig. (36): Diagram of Investment in Electric Power Industry Facilities

(10^9 Rials)



Environmental ISSUES

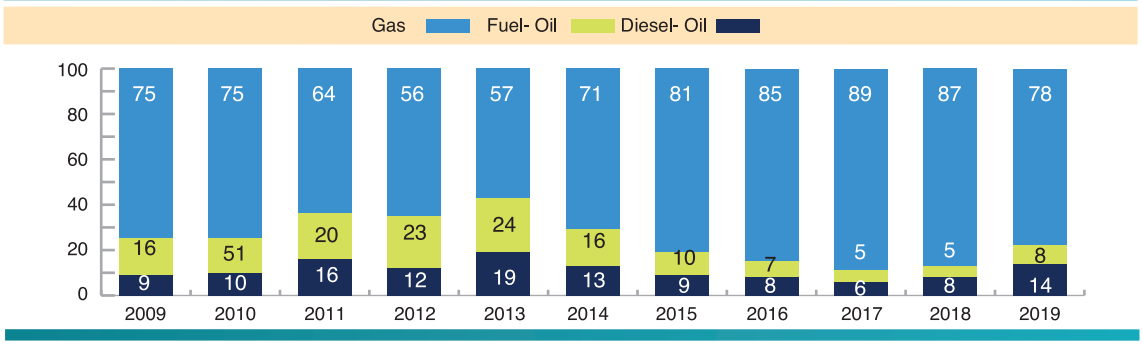
A. Health, Safety and Environment (HSE) in the Electric Power Industry[1]

Safety, health and the environment (HSE) is one of the most important issues that everyone at every level in the work and living environment should pay attention to and neglecting it will sometimes cause irreparable damage and loss to the life of the individual and even colleagues. Furthermore, It causes a lot of damage to the environment, which is a cause for great concern. The point that should never be overlooked is that danger is always lurking. Therefore, we must always think about reducing the damage caused by potential hazards. This means that even if we take all the necessary precautions, we may still be in danger from issues that are far from our minds or due to the mistakes and negligence of others. Now, if we want to protect ourselves and others from the bites of these dangers or to reduce their effects to a minimum, we must make arrangements. The first thing we need to pay attention to is the right and logical thinking and the right approach in preventing danger. We must remember that the occurrence of excessive stress and obsessive behaviors due to the fear that there are always dangers that lie in wait for us, not only will not help solving the problem, but will also lower the efficiency of the person and experience has shown that such encounters and behaviors, if they do not create a new problem, certainly will not solve the existing problems. The electric power industry, as one of the mother and prosperous industries, has given priority to health, safety and environment. In this regard, due to the responsibility of the electric power industry in maintaining and improving the environment, ensuring the health and safety of all employees, customers and other people affected by this industry, the establishment of a comprehensive HSE management system in the electric power industry is necessary and all facilities to achieve No event, damage and destruction of the environment will be used. In this regard, the Health, Safety and Environment Supervision Office of the company will make every effort to cover all issues and subjects related to all three areas of health, safety and environment in Tavanir Company and its subsidiary companies and take action to provide appropriate conditions and a safe and hygienic environment.

Measures taken in the field of health, safety and environment (HSE)

1. Receiving events reports of regional electric power companies and electric power distribution companies and analyzing events and preparing and announcing improvement opportunities and management reports
2. Identifying some training needs and following up to hold courses in the field of HSE in Tavanir Company and its subsidiary companies with the aim of improving the level of training and increasing the skills of employees.
3. Investigating occurred human events and analyzing them and providing expert solutions to reduce risk and events factors and preparing and sending event analysis reports to management.
4. Measures to deal with coronavirus (COVID-19): Collecting daily statistics in Tavanir Company and its subsidiary companies, preparing management reports, purchasing thermometers, communicating relevant circulars and preparing the necessary instructions and brochures to inform Tavanir Company and its subsidiary companies as well as monitoring and preparation of management reports.
5. Necessary measures in order to protect the environment and management and disposal of waste: Cooperation and supervision regarding the management and disposal of normal and special waste in the electric power industry based on notification rules and international

Fig. (37): Diagram of Share of Various Consumption Fuel in MOE Thermal Power Plants



1. Report sent from Tavanir Company Transmission Coordination Deputy HSE Office

conventions and attending relevant meetings and pursuing to obtain performance reports of subsidiary companies and preparing reports and sending them to relevant authorities.
6. Implementing green management programs, following up to implement green management activities of the relevant units in Tavanir Company, holding working group meetings, following up the working group approvals and making the necessary arrangements to attend Shahid Rajayi Festival.
7. Evaluation of green management of subsidiary companies in the determined period in Shahid Rajayi Festival
8. Preparation, compilation and communication:

- The executive method of occupational health of Tavanir employees and subsidiary companies
- Instructions for places hygiene of Tavanir Company and its subsidiary companies
- Executive instructions on how to perform medical examinations and criteria for issuing health cards for drivers of Tavanir Company and its subsidiary companies
- Instructions for issuing medical examination cards of Tavanir Company and its subsidiary companies

9. Governing the project of the comprehensive plan of environmentally friendly technologies in the energy sector of the country in the area of Tavanir Company
10. Cooperation in leading the energy optimization project in the building to carry out this project in the buildings of Tavanir Company using the budget of the Vice-Presidency for Science and Technology and UNDP

Ongoing work of the Office of Health, Safety and Environment:

- Planning to hold meetings of specialized working groups and compiling and updating the same instructions and executive methods for all subsidiary companies on issues related to health, safety and environment and activating sub-working groups.
- Planning to establish HSE management system at the level of all subsidiary companies in order to standardize management systems at the companies' level
- Holding general webinars in the field of HSE to improve the general knowledge of Tavanir Company's personnel
- Planning, holding and following up the implementation of the approvals of the meetings of the Green Management Working Group at the level of Tavanir Company
- Promoting the culture of social responsibility in the electric power industry holding meetings of the Supreme Council of Social Components in Tavanir Company and its subsidiary companies
- Coordinating and holding a meeting to make the necessary amendments to the safety regulations in electric power transmission operations.

Future Goals of Health, Safety and Environment Supervision Office:

1. Establishing communication channels with related companies such as the Ministry of Health, Department of Environment and associations.
2. Pursuing to reform the organizational structure of HSE offices in all subsidiary compnaies.
3. Monitoring the creation of a healthy, safe, event-free as well as damage to the environment free working environment.
4. Protection of human resources, protection of the environment and capital of the electric power industry.
5. Improving the level of knowledge and information in the field of health, safety and environment.
6. Cooperation in holding training courses related to health, safety and environment in Tavanir Company and its subsidiary companies.
7. Optimization in electric power industry in order to apply new experiences and useful practices in issues related to health, safety and environment in electric power industry.
8. Deployment of HSE software in Tavanir Company and its subsidiary companies.
9. Cooperation and coordination with other offices to improve performance.

B. Environmental Issues in Electric Power Industry[1]

Nowadays, different methods are used to generate electricity. The most important factors in choosing the type of generation method are the geographical and climatic conditions of the region, economic and technical factors and related environmental issues. Due to the global environmental situation and the significant effects of the energy sector on it, the general tendency is to use methods with higher efficiency and electricity generation with less pollution. Although

1. The sent report from the Environment office of Thermal Power Plants Holding (TPPH) Company

economic issues may still be the most important factor in choosing the method of production, this is especially evident in developing countries. In countries with fossil fuel resources, the use of fossil fuels to generate electricity is still cheaper than other methods. But in general, it can be said that the use of renewable energy instead of using fossil fuels to generate electricity, due to the set of economic factors and local and global environment is gradually expanding. At present, the main methods of generating electricity can be divided into three main categories:

- Use of fossil fuels
- Use of nuclear energy
- Using renewable energies

Each of the above categories includes different methods of generating electricity. From a general point of view, electricity generation methods with fossil and nuclear fuels produce the most pollution, which depending on the production method may be gases, suspended particles, types of effluents or solid and hazardous waste. Electricity generation using fossil fuels can be done with one of the types of diesel power plants, gas turbines, steam heaters, combined cycles and using gas fuels, gas oil, furnace oil or coal. renewable energy also includes the use of sources such as wind, solar, geothermal, oceans and tides to generate electricity. Among the renewable energies, we can mention the use of water energy and hydropower plants. In this section, each of the power generation technologies and production processes in them are briefly examined.

Electric Power Generation Pollutant and Greenhouse Gases Emission State

According to the existing information in the database, the amount of pollutant gases and greenhouse gases emissions generated by the activity of power plants by type of fuel in 2019 is as follows:

Table (4): The emission rate of environmental pollutants in thermal power plants in 2019 (gr/kwh)

NO_x	SO_x	CO_2	CO	CH	SPM
0.881	1.343	564	0.001	0.030	0.099

1- The sent report from the Environment office of Thermal Power Plants Holding (TPPH) Company

Table (5): The amount of environmental pollutants in thermal power plants by type of consumed fuels in 2019 (tons)

Fuel Type	Consumed Fuel Amount	NO_x	SO_x	CO_2	CO	CH	SPM
Fuel oil	5350711 (Thousand Liter)	23010	219290	13704458	17	1841	4602
Gasoline	10038710 (Thousand Liter)	49393	151409	25152531	38	3030	9461
Gas	58287479 (Thousand m3)	170980	329	116891299	274	3233	13152
Total		243383	371028	155748288	329	8104	27215

The Most Important Performed Actions at the HSE Office of Thermal Power Plants Holding Company (TPPH) to Protect Environment

- Establishment of an integrated online environmental monitoring system for power plants
- Transfer of environmental monitoring system of thermal power plants from SATBA to the Thermal Power Plants Holding Company (TPPH)
- Supervising the correct installation of online monitoring equipment in power plants, forming a technical committee and preparing technical documents by the HSE unit and sending the mentioned documents to the subsidiary power plants
- Reviewing and conducting technical studies to identify various methods of removal of sulfur compounds
- Carrying out feasibility studies and techno-economic evaluation of the Low NOx burner replacement plan
- Investigating the status of PCBs oils in the generation sector of the electric power industry
- Review of projects environmental impact assessment reports
- Periodic monitoring of power plants from the perspective of health, safety, and environment (HSE)
- Attending the provincial, technical and Article 2 committee meetings of the under construction projects
- External interactions in line with national and international requirements
- Interacting with the Ministry of Energy (MOE): membership in the strategic committees, think tank and Ministry of Energy (MOE) carbon commitments
- Monitoring and providing technical advice on corrective action for environmental pollution in the field of air, water, soil and noise pollution of power plants and formulating a strategy and presenting optimization plans in this regard
- Environmental monitoring and evaluation of compliance of power plants with standards and presentation of impact reduction plans
- Preparation and formulation of policies, requirements, guidelines and performance indicators in the field of HSE in subsidiary companies
- Identifying and communicating HSE laws to subsidiary companies
- Developing and communicating HSE instructions to subsidiary companies
- Monitoring the proper implementation of HSE requirements and guidelines in subsidiary companies and conducting periodic evaluations
- Evaluation, audit and monitoring of environmental activities in all power plants
- Review of performance indicators of power plants in the field of environment

Research Activite

Introduction

The Research and Technology Development Office of Tavanir Co. is responsible for policy-making, management, supervising research activities of Tavanir Co. and its subsidiaries and supervision, inspection and quality control of the utilized equipment in electric power industry. It includes four professional groups as follows:

- Group of coordination and evaluation of Tavanir Co. subsidiary companies researches
- Group of national and development projects
- Group of coordination and connection with scientific and research centers
- Group of technology development and standards
- Group of inspection and quality control of manufactured equipment in electric power industry

Research Activities

- Governing, guiding, supervising and coordinating the research activities of regional electric power companies, distribution electric power companies, and Iran Grid Management Co (IGMC) and creation of scientific and professional connection with universities and academic communities.
- Evaluating the proposed research projects in expertized committees from different scientific, technical and economic aspects and checking them to be not repeated and execution of about 189 approved research projects in subsidiary companies in 2019.

Table (6 - 1): Number of research projects supervised by Tavanir Co. subsidiary companies from 2015 to 2019.

Research Projects	2015	2016	2017	2018	2019
In Progress	410	392	292	473	391
Accomplished	99	140	192	217	271

- Holding 56 meetings of evaluating researches plan and budget of subsidiary companies and approving the budget of 2019 and predicting budget of 2020
- Evaluation of 2089 proposed research titles and approving about 576 electric power industry research priorities in 2019
- Cooperation in holding the Research Festival in Research Week
- Improvement of electric power research portal and implementation of electric power research processes through the aforementioned portal
- Updating electric power researches portal in order to gather projects information of country's electric power industry research activities
- Facilitating the commercialization process of research projects results
- Cooperation and supervision on the development of national standards about transmission protection relays power supplies, Transformers (PT, CT and Composite), DC and AC measuring equipment, Distributed Generation (DG), duct systems for cabling, composite insulators, voltage detectors, electrical safety, small energy systems for electrifying villages, electromagnetic disturbances, solar and wind energies, concrete towers of distribution sector
- Conducting applications for utilizing electric power industry standards and the related links and the CD containing standards.

- Assisting Iran National Standards Organization (INSO) in the development and supervision of national standards in the fields of electric power circuit breakers, photovoltaic, electric power equipment safety, high voltage pressure relief circuit breakers and disconnectors
- Gathering electric power industry standards books and sending most of it to the library of Tavanir Co for public use
- Holding the governing committee of robotics technology in order to policy making about utilizing robotics technology in distribution, sub-transmission and transmission sectors with the cooperation of subsidiary companies and universities and constituting professional working groups
- Making two research contracts in the field of robotics through subsidiary companies
- Cooperation and participation in the Electric Vehicle (EV) governing committee at Niroo Research Institute (NRI)
- Supervising projects related to nanotechnology, including "Use of nanotechnology in the cathodic protection of concrete transmission towers" and "Use of nanocomposite protective layers to prevent corrosion in power transmission systems"
- Supervising the project "Evaluation and study of SCADA software for power distribution control centers"
- Supervising the project "Development of operation instructions of Unmanned sub-transmission substations"
- Supervising the project "Construction of energy tunnels inspection robot in the form of moving on the ground rail and moving on the roof"
- Supervising the project "Development of software platform for fault detection of transmission and sub-transmission lines equipment using flying robots"
- Supervising the secretariat of electric power industry standards to assess, compile, review and supervise standards and guidelines related to the electric power industry
- Cooperation and participation in the nano technology governing committee at Niroo Research Institute (NRI) (evaluation of 23 projects)
- Supervising the performance of electric power industry large-scale projects and plans through the governing of large-scale projects
- Prioritizing and anticipating the required budget to support the equipping and establishment of reference laboratories for transmission and distribution sectors
- Identifying the problems and developing the research requirements of Tavanir Co
- Executing the secretariat activities of Tavanir Co. research and technology committee. In this regard during 2018, scientific and research activities, and the implementation of research projects with universities and scientific and research centers related to the electric power industry were supported.
- Governing and supervising different research projects by Office of Electric Power Research Affairs of Tavanir Co. in 2019

Table (6 - 2): Number of research projects of Tavanir Co. from 2015 to 2019.

Research Projects	2015	2016	2017	2018	2019
In Progress	24	21	13	11	39 with Paragraph H 25 without Paragraph H

List of Tavanir Co. Accomplished Research Projects in 2019

- Designing GIS-Web system for publishing an integrated GIS database of transmission and sub-transmission network of electric power industry
- Integrated monitoring and management of processes and information aggregation of research projects of subsidiary companies

Electric Power Industry Special Equipment Inspection and Quality Control Activities

- Issuing certificate of compliance with production standards for 606 types of specialized electric power industry goods
- Qualifying 233 companies and issuing standard compliance certificates for them
- Supervising the establishment of a quality control program for the production line of specialized equipment inside the country and abroad with the assistance of the qualified inspectors approved by Technical and Commercial Committee (more than 100 companies) and its publication and sending the received requests for passing the levels required for obtaining the certificate of standard compliance
- Identifying and exchanging memoranda of understanding with associate laboratories in the electric power industry to prevent foreign currency outflow
- Developing and editing the specialized electric power industry goods instructions

Privatization in Electricity Industry

Privatization in Electric Power Industry with Regard to General Policies of article 44 of Iran's Constitution

Electrical energy consumption growth has accelerated in recent years. Consumption growth of subscriber and increase of their expectation of the level of quality of public services needs significant, dynamic and coherent investment in the electricity industry. Finance of these investments by governmental sector will impose a burden on the national budget and can't meet all the needs of this industry.

Increase the level of productivity of electricity industry needs to develop financial resources and competitive level in order to give better services and reduce the cost price electricity. Also giving the activities of the takeover and focusing on governance duties is one of the reasons that companies affiliated to the electricity industry have been pioneered in the private construction of the country.

With preparing and releasing investment environment, the admission of capital and managerial capacity of the private sector has been provided.

Some of the Electric Power Industry Strategies to Attract the Private Sector Participation

- Using facilities provided in article 53 of the law on incorporation of some laws to the law on the regulation of a part of governmental financial regulations (1) and article 224 of the fifth five-year government economic development plan, which regulates the utilization and empowerment of the private sector in the activities of the company using managed funds resources for implementing effective plans for loss reduction.
- Use of the Law to eliminate production limitations in order to attract the participation of private sector investors to finance the projects that are effective for loss reduction.
- Providing guidelines for specifying sample areas for the possibility of private sector investment in effective plans for loss reduction.
- Providing Contract for the purchase of energy saving from investments in the previous clause.
- Receiving 10% of electricity sales as electricity tax to provide the required financial resources for renewable and clean electricity generation and implementation of rural electricity network development and maintenance plans
- Possibility of making contracts with private and public sectors investors in order to implement loss reduction and energy efficiency plans with the priority of using of domestic built devices.
- Creating opportunity for private sector investors to execute small-scale power plants development plan.
- Allocation of a part of energy generation for exporting electricity to foreign countries.

Activities Related with Handing-over of Electric Power Distribution Companies

In accordance with paragraph 9 of decree No. 243641 dated 2016 /03 /09 of the Board of Trustees, the issue of "reforming the structure of electric power distribution companies" was presented at the meeting and in implementing the current regulations, including issue (b) of article (19) of the law of implementing general policies of article (44) of Islamic Republic of Iran's Constitution and subject to the provisions of paragraphs (6) and (9) of the enactment of the Law on the independency of electric power distribution companies, and subject to the provisions of contracts of leasing conditional to ownership of the assets and facilities of electric power distribution section, Iranian Privatization Organization (IPO) and Ministry of Energy (MOE) were obligated to modify the structure and preparation of electric power distribution companies within the specified framework within a maximum one year. Therefore, in accordance with the decree No. 120669/T51112H of 2015 /01/ 04 the Cabinet of Ministers and the decree of Transferring Supreme Council dated 2017 /01/ 28, electric power distribution companies were removed from the list of transferable companies.

Future Prospects

Future Prospects

Some focal points of the Electric Power Industry within the Fifth Socio-Economic Development Plan of I.R. Iran are loss reduction, power plant efficiency increase and load management. Operation of new installations, considering the demand for electricity and high rate of demand for electricity in the country, coordinating them with the existing installation, upgrading the quality of operation and service to the customers, decrease of costs of electric power generation using the continuous development of technical know-how, which by itself can be a lengthy discussion demanding hard task and heavy investment, all and all are seen at the horizon ahead of the Electric Power Industry and have been put on the agenda of this industry. In this section, we will have a glance at the future of the Electric Power Industry and its main development direction in the Fifth Socio-Economic Development Plan of the country and will compare it with the present situation. Table 14 demonstrates the feature of the Electric Power Industry at the end of 2019.

Generation

The planning for the electric power generation capacity increase of the country in the future years is based on the following policies:

- Considering the development of combined cycle power plants with higher efficiency and lower pollution considering the technology development and indigenization of such power plants equipment and increase of thermal power plants efficiency
- Accomplishment and operation of all under construction hydroelectric power plants
- Increasing the reserve factor of the generation system as well as improvement of the stability & reliability of the system from to the desired level and minimization of the electric power outage index
- Provision of a more competitive environment for private sector participation in the field of power plant construction under B.O.O. & B.O.T. schemes
- Activating the power market for creating competitive environment in the generation and distribution sectors, increasing economic productivity and providing the required resources through the presence of the non-governmental sector in investment

As it is estimated, the installed capacity of (governmental and private) power plants of the country may reach to 86000 MW by the end of 2019 that means until 2019, 2293 MW has to be added to the existing power plant capacity of 2018.

It is anticipated to accomplish 2074 MW of this capacity increment through the private sector participation under two worldwide known schemes namely B.O.O. and B.O.T.

Tables 12 and 45 present the time-table of all confirmed power plants including private and governmental power plants. The increasing trend of the capacity of all types of power plants from 2020 to the end of 2023 is as follows:

Combined Cycle Power Plants

The nominal capacity of combined cycle power plants will increase by approximately 1634 MW by the end of 2020 (It is worth mentioning that usually these power plants are gas type that will be gradually converted to combined cycle type). In 2019, capacity of combined cycle power plants was 27129 MW and capacity of these kinds of power plants will increase by 28603 MW by the end of 2020. The country's electric power generation by combined cycle power plants increases efficiency, decreases fossil fuel consumption and has positive environmental impacts. Furthermore, installation of such power plants is faster and easier than thermal power plants.

Gas Power Plants

Less investment cost, shorter construction time, less fixed operating costs, faster commissioning, more maneuverability and the possibility of indigenization of large parts of gas power plants equipment compared to other power plants, especially steam power plants are the benefits that has caused more attention to this type of power plants in the past. It should be mentioned that by operation of each unit of the steam section of the combined cycle power plants, the relevant gas units will be eliminated from the statistics of the gas power plants and will be added to the statistics of the combined cycle power plants.

Steam Power Plants

By the end of 2020, no new steam power plant will be added. With the same capacity by the end of 2019, the total capacity of this type of power plant will reach to 15829 MW that is 18 percent of total power plant capacity of the country by the end of 2020.

Hydro-Electric Power Plants

The construction of hydroelectric power plants has always been appreciated because of no use of fossil fuels, no environmental pollutants generation, flood control, controlled water release and cheap electricity generation and other benefits. In recent years, the process of building this kind of power plants has increased and their share in electrical energy generation has increased. By completion of under-construction hydro-electric power plants, 350 MW will be added to the present capacity of this type of power plant from 2020 to the end of 2021 and the total capacity of this type of power plant will reach to 12542 MW that is 14 percent of total power plant capacity. Hydro-electric power plants due to high maneuver capability in operation are of brilliant importance in power system stability.

Construction of New Nuclear Power Plant

Atomic Energy Organization of Iran (AEOI) has prepared tender documents for construction of two new units of nuclear power plant of the third generation of pressurized light-water reactor type with capacity 10001600- MW in accordance with aims and duties and also legislation of the Islamic council dated in 22 May 2005 based on releasing the nuclear energy to extent of 20000 MW of total electrical energy generation in the country. These tender documents have been drafted in the structure, details and general principles as follow:

- Experience of first unit of nuclear power plant in Bushehr
- Strategy of constructing 20000 MW of nuclear electricity
- Explaining report of constructing the second nuclear power plant

Table (7): Outlook of the Electric Power Industry at the end of March, 2020

Description	Unit	Quantity
Installed Capacity (The Whole Country)	MW	83506
Installed Capacity (MOE)	MW	37276
400kV Transmission Lines Length	km-Circuit	21329
230kV Transmission Lines Length	km-Circuit	32571
132kV Sub-Transmission Lines Length	km-Circuit	23939
63,66 kV Sub-Transmission Lines Length	km-Circuit	50205
400 kV Transmission Substation Capacity	MVA	75008
230 kV Transmission Substation Capacity	MVA	88535
132 kV Sub-Transmission Substation Capacity	MVA	36227
63,66 kV Sub-Transmission Substation Capacity	MVA	78306
Medium Voltage Distribution Lines	km	439308
Low Voltage Distribution Lines	km	373124
Capacity of Distribution Transformers	MVA	128380
Max Supplied Load	MW	57104
Max. Demand	MW	57861
Annual Electricity Generation	GWh	326431
Number of Customers	10^3Customers	36644
Electricity Sale	GWh	275094

- Regulations of nuclear power plant in Europe
- Recommendations of IAEA

Without doubt the realization of 20000 MW of nuclear electricity needs proper positions in accordance with the rules and regulations of nuclear safety office and international standards. In this regard, Atomic Energy Organization of Iran (AEOI) has been drafted the bid documents to elect new positions in the country and identification stages of qualified advisors have been in action.

Table (8): Operational Trend Forecast of New Power Plants (MW)

Discretion	2020	2021	2022	2023
Gas, Combined Cycle	1634	3153	1842	842
Hydro	59	291	0	0
Renewablle En.	300	200	200	200
CHP.D.C	300	300	300	300
Total	2293	3944	2342	1342
Total Increase	85799	89743	92085	93427

Distributed Generation (DG) Units and Combined Heat & Power (CHP) Generation

Using the distributed generation units with high efficiency in the distribution networks cause loss reduction and fuel consumption reduction. If along with this kind of units, facilities to produce heat, warm water and desalination are installed in the suitable regions, the total efficiency including electrical and thermal efficiencies because of the use of heat dissipation in electric power generation equipment will become about two times. Therefore, construction of this kind of power plants causes efficiency increase and fuel consumption decrease.

In 2020 and in pursuit of the objectives of resistive economic policies, construction of 30 MW of Distributed Generation (DG) units is planned by the private sector in the generation expansion planning program. It is also predicted that by the end of the Sixth Socio-Economic Development Plan of I.R. Iran, 450 MW of this type of power plants will be added to power plant capacities by the private and governmental sectors.

Modernization of Steam Power Plants

The average age of existing steam units in the country is more than 30 years. Some of these power plants with a life span of over 40 years are still generating power. Obviously, increase in the life of units will reduce the generation power, increase the emergency outage rate and increase the repair cost. Therefore, it is necessary to rehabilitate or repower the old units. In the reconstruction plan of the units, faults, weaknesses, and faulty components and equipment are detected through the necessary technical examinations and the faults are removed and the faulty components and equipment are replaced. The main purpose of the unit's reconstruction plan is to compensate for the drop of generated power and units efficiency as well as to increase life time, increase stability and reduce their emergency outage rates.

In some cases, due to the high operating hours of the units, it is not economically feasible to implement the reconstruction plan. In these cases, repowering plan can be used. In this way, instead of steam units boilers which include most of the units problems, high-efficiency new gas units with heat recovery boilers (HRSGs) are used. In this scheme, ordinary steam units are converted to a combined cycle block. Therefore, increase in generation power due to the use of gas turbines causes a significant increase in efficiency. Among the 17 existing steam power plants, 14 power plants have the necessary conditions for examining and implementing the above plans.

Compensation of Generation Decrease Reduction in Gas Units and Combined Cycle Due to increase in Inlet Air Temperature:

Temperature increase theoretically decreases mass debit of the flowing air through the compressor and as a result the combustion products passing through the gas turbine decreases, resulting in a reduction of about 10 to 12 percent of the generation power in gas units. In order to compensate for this reduction, inlet air cooling is carried out according to the weather conditions and various methods as follows:

- **Fog:** It is based on the spraying of water into the inlet air of the compressor after the filter. This system has been implemented in some units of Montazer Ghaem, Shahid Rajaee, Qom and Yazd power plants and has the potential to generalize to other power plants considering the financial requirements and transfer process of power plants.

- **Media:** These systems operate based on water spraying on cellulosic filters that are installed before the main filter of the compressor and humidify the air. By implementing this system in Fars, Kazeroon, Damavand, Zavareh, Shahid Kaveh, Shirvan, Kerman, Shahrood, Yazd, Bampur, Jahrom, and Mashhad power plants about 590 MW is added to the national grid capacity at summer peak and installation of this system in units with this capability is under planning. Fog and media systems have a good result in dry areas. In the humid and semi-humid areas where these systems are not responsive, three major approaches are considered:

- **Chilling:** This method operates based on the type of cooling of absorption or condensation and cools the air. Its investment cost is higher than other methods but its important advantage is that it does not need water.

- **Swirl flash:** This approach has been successfully implemented in one of Gilan power plants units. It is based on increasing water pressure and temperature and spraying before the compressor and creating droplets with a diameter of five microns.

- **Wet Compression:** In this method, water particles are injected to air with high pressure. Water injectors are located at the inlet of the compressor (the end of the air inlet channel). The rate of water injection is more than Fog and Media methods. It is implemented in one of Paresar power plant units and has been able to increase power by 15 MW.
  By the way, the cost of implementing cooling systems is about 10 to 15 percent of the cost of purchasing new units. It should be noted that most parts of these systems are built inside the country.

Transmission

Regarding the increase in power generation capacity of the country, plan for construction of transmission and sub-transmission lines along with the power substations to meet the electricity demand of the country has been also included in the Sixth Development Plan. These installations are to be used for transmission of generated power and energy from new power plants to the subscribers, to improve the system reliability and cover larger area than that covered by the National Grid. Table 9 - 1 demonstrates the annual increase of these new installations.

Table (9-1): Forecast of Extensions in Sub-Transmission and Transmission Installation Until End of 2022

Description	Voltage (kV)	End of 2019	End of 2020	End of 2021	End of 2022	Annual Growth (%)
Transmission Substation Capacity (MVA)	400&230	163543	168829	173976	179339	3.09
Sub-Transmission Substation Capacity (MVA)	63&66&132	114533	116903	119459	122271	2.19
Transmission Lines Length (km-Circuit)	400&230	53900	54566	55094	55598	1.03
Sub-Transmission Lines Length (km-Circuit)	63&66&132	74144	75286	76580	77923	1.65

Distribution

Development of distribution network is a function of number of customers, type of customer, dispersion of customers, urban development and rural electrification program. Table 92- shows the annual increase of some of these parameters during years 2020 to 2023. As it can be observed from this table, the number of subscribers of Electric Power Industry, with annual average rate of growth of 2.9 percent will increase from 37705 thousand customers to 39921 thousand customers and the energy sell with annual growth rate of 5.4 percent would increase from 289969 Million kWh to 322174 Million kWh. The length of distribution lines with annual average rate of growth of 1.8 percent will reach to 856000 km and the capacity of distribution substations with average annual growth rate of 2.5 percent will increase to 138537 MVA.

Table (9-2): Forecast of Extensions in Distribution Installation Until End of 2022

Description	Unit	End of 2019	End of 2020	End of 2021	End of 2022	Annual Growth (%)
Nomber of Customers	10^3 Customers	36644	37705	38797	39921	2.9
Energy Sales	10^6Kwh	275094	289969	305647	322174	5.4
Distribution Lines Length	Km	812432	827018	841866	856980	1.8
Sub-Transmission Substation Capacity	MVA	128380	131680	135065	138537	2.5

IEPI in the World Arena

Electric Power Industry in the World

Today the social, political and economic crisis and the issues such as restrictions endured fossil reserves, environmental concerns, crowds, economic growth and consumption index are the subjects that are thought by thinkers' to find the suitable strategies in solving energy problems in the world, especially environmental crises. On the other hand since the political and economic support of countries depends on the rate of productivity fossil energy sources, to be empty fossil resources is not only a threat to the economy of the exported countries, but also is the main concern of economic system of the imported countries. Current using of the fossil reserves may lead to less productivity and ultimately to be empty the reserves in future.

Fortunately most countries of the world have been realized to importance and role of various resources of energy especially renewable energies in supplying the present and future needs and have done great researches and principle investments in the operation of development of these resources. With regard to such increasing and main tendency in using the renewable energies and its technologies in industrial and in-developing countries, it is necessary that basic strategies and plans are followed.

Pollutants caused by the combustion and increasing the density of CO2 in the atmosphere and its consequences have faced the world with irrevocable and threatening changes. The increase in temperature on earth, climate changes, sea levels and eventually intensified international conflicts are some of these consequences. This has persuaded the policy makers to offer policies and standards for control of environmental and researchers to develop resources with less pollution and renewing.

All renewable energy resources share more in energy supply system in the world. The sources simultaneously answer to both main features of fossil resources as follows: renewable energies are compatible with environment and have not any pollution and because of renewing, there is no final for them. Another characteristic of these resources is their distribution and to be widespread in the world. Therefore, a special role has been allocated to these resources in the international policies and programs such as in programs of United Nations in other to global stable development. However adjusting these resources with the current system of energy consumption in the world has still some difficulties that for solving them important scientific researches in recent years have been allocated.

In other hand the technology of construction and operation of each energy, environmental issues, technical characteristics, possibility of having access, the geographical distribution and other features have its own characteristic. Therefore, the variety of use of various energies will be caused country to have more reliable situation and it is necessary that their technologies is established in the country. Of course, the technology which is dependent on industry greatly is raw material of internal resources, and needs less foreign currency and on the other hand employment opportunities and increasing domestic production are realized. To reach this goal, it is necessary to modify the real prices of various energies and the essential measures are done to promote private sector.

According to presented programs by country's electricity industry in short-term period in a next decade, access to electronic power systems will be provided in electricity industry based on Silicon or Post Silicon to control of power supply system. Integration of decentralized generation and local storing in the form of a new architecture is proper for the future competitive market. On the other hand, country's electricity industry will follow new and proper services which interact with customers and based on customer needs. To accelerate in the world using of clean fossil technologies which are the most efficient and best methods to generate electric energy is of other measures that will be done in country's electricity industry. One of goals of country's electricity industry is development of electric energy generating systems in short-term periods that is proper in environmental features for in-developing countries.

As well as accelerating in the research and development projects in order to increase productivity of equipment for electric power costumers is from other cases that country's electricity industry pay attention to it in short-term goals. All these cases are caused that general policies of electricity industry are organized toward using of equipment and new technologies and knowledge in electricity industry.

In connection with general goal of power industry it should be mentioned that in the long term with a look at the perspective of the future, global use of electric power for better use of energy resources, the earth, water and to minimize industry, agriculture and cities garbage to create a framework for stable future is planning. On the other hand comprehensive development and compatible with the global prospect in the field of power supply reduce costs and improve environmental performance of the infrastructures is concerned. In other words to create new facilities compatible with the needs besides development, technology and innovation in this industry it must move in such way that it is befitted of the best facilities.

For example, electric based transportation may increase the electricity consumption of the world up to 15 percent in the next 50 years that in turn would reduce the consumption of oil products. It should be noticed that this trend does not necessarily mean the increase of electric power generation through traditional means of electric power generation, (considering the overview, which exists about fuel cells and technological development for storage of electricity).

Looking more curiously to the future energy consumption shows that utilizing nuclear energy development is complying with environmental issues. Making managerial decisions for different countries may be varied according to each country situation. Development of the nuclear power plants becomes more attractive when energy demand is growing very quickly. As nuclear technology is improving worldwide continuously and several countries are obtaining and reaching this technology edges, considering some new aspects cannot be neglected. Quality warranty, management and dividing the know-how and applying the international accepted standards, considering necessary security and protection issues and improving cooperation levels are some of the issues.

Most of new nuclear power plants in the near future will be based on the new and developed plans and of course with the previous system. Now 20 members of IAEA are currently engaged in providing new reactors and new plans of fuel cycle.

With the increasing prices of fossil fuels, renewable energies will find the special position in the energy supply in the world. In next 20 years, the need of world energy will increase about 60 percent. This is while that in the 21st century A. D., energy fossil-fuel resources such as coal, oil and gas fuels are finishing. The future of energy of the world is dependent on science and technology development in production and consumption of energy, the prices and decision-making politicians in the field of energy. Now due to the high cost, renewable energies may not challenge with the fossil fuels. However with increasing in fossil fuels prices, renewable energies will have a special position.

The shares of nuclear and renewable power plants in some countries of the world are shown respectively in Figures 38 and 39. Furthermore, Figures 4043- show the average growth of installed capacity, generation, consumption and population respectively for the past 10 years in different regions of the world.

In Tables 47 and 48, forty countries from the viewpoint of population, installed capacity, net production, electricity consumption, electricity exports and imports, per capita capacity, per capita production, per capita consumption and utilization index, as well as ranking of these indexes are compared.

Fig. (38): Diagram of Contribution of Atomic Power Plants to Installed Capacity of a Number of World's Countries at the end of 2018

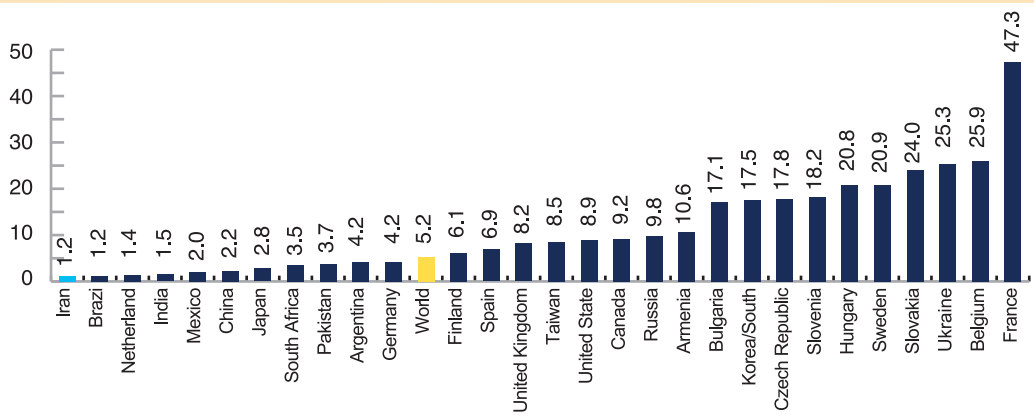


Fig. (39): Diagram of Contribution of Renewable Power Plants To Installed Capacity of a Number of World's Countries at the end of 2018

(%)

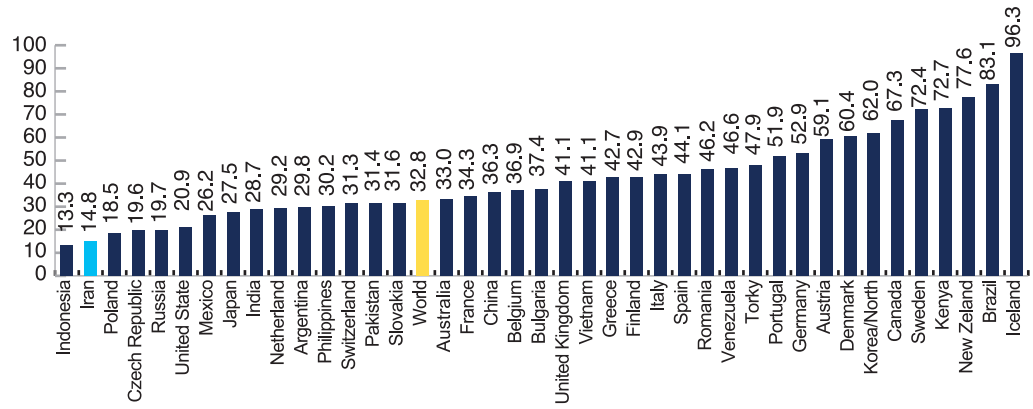


Fig. (40): Diagram of Average Percent Growth of Installed Capacity during the Past Decade

(%)

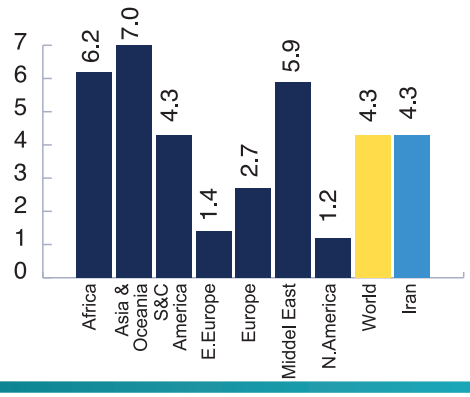


Fig. (41): Diagram of Average Percent Growth of Electricity Energy Generation During the Past Decade

(%)

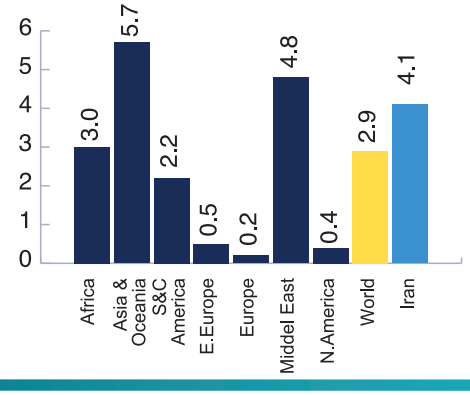


Fig. (42): Diagram of Average Percent Growth of Electricity Energy Consumption During the Past Decade

(%)

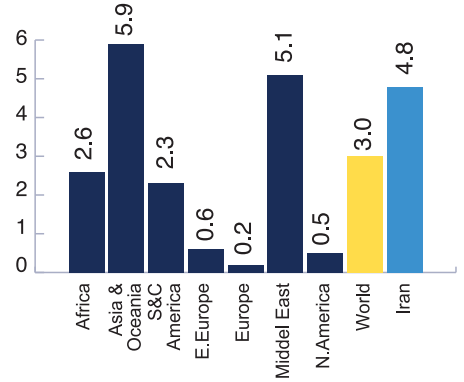
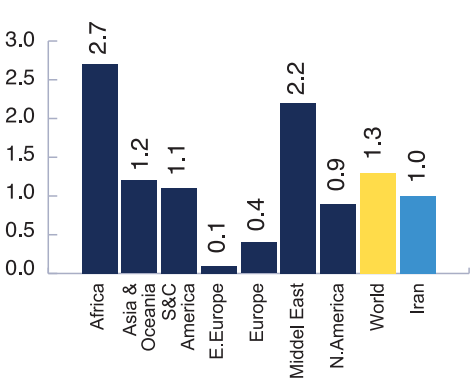


Fig. (43): Diagram of Average Percent Growth of Population During the Past Decade

(%)



Complimentary Tables

Table 10-1 : Iranian Electric Power Industry at a Glance

Description	Unit	2018	2019	Change (%)
General Indices				
Capacity per Capita	Watt	972	997	2.6
Electricity Production per Capita (MOE)	kWh	3735	3896	4.3
Electricity Consumption per Capita (MOE)	kWh	3137	3283	4.7
Average Household Consumption	kWh	2960	3007	1.6
Utilization of Effective Capacity of Power Plants	%	50.9	51.4	0.9
Average Efficiency of MOE Thermal Power Plants	%	38.1	38.6	0.5
Load Factor	%	72.7	65.4	-6.9
Power Cut/ Customer	Min/Day	1.62	1.51	-6.8
Customers Density per km^2	Customer	22	22	0.0
Customers per Employee	Customer	769	806	4.9
Residential Consumption	%	32.8	32.2	-0.6
Export Share From the Total Sold and Consumed Energy	%	2.37	2.68	0.31
Share of Electricity Consumption Productive Sectors.(Agri+Ind)	%	48.7	49.4	0.68
Employee per Installed Capacity	kW	1734	1837	5.9
Productivity of Employee	MWH/Person	6662	7183	7.8
The Ratio of High Educated Staff to Total	%	64	66.5	2.5
Installed Capacity	MW	80467	83506	3.8
Hydro	MW	12026	12192	1.4
Steam	MW	15829	15829	0.0
Combined Cycle	MW	24995	27129	8.5
Gas	MW	25552	26180	2.5
Diesel	MW	439	439	0.0
Nuclear & Renewable Energy	MW	1626	1736	6.8
Max. Supplied Load	MW	53701	57104	16.4
Max. Demand	MW	57270	57861	1.0
Total Energy Generation	GWh	309182	326431	5.6
Hydro	GWh	15765	31082	97.2
Steam	GWh	85655	85115	-0.6
Combined Cycle	GWh	129201	31149	-75.9
Gas	GWh	70320	71216	1.3
Diesel	GWh	81	39	-51.9
Nuclear & Renewable Energy	GWh	8160	7828	-4.1
C-Energy Losses	%	10.98	10.32	-0.66
Transmission & Sub-Transmission	%	2.81	2.76	-0.05
Distribution	%	10.41	9.76	-0.65

Table 10-2 : Iranian Electric Power Industry at a Glance

Description	Unit	2018	2019	Change (%)
Fuel Consumption (MOE)				
Gas oil	10^6 Liter	5970	10253	71.7
Fuel oil	10^6 Liter	3451	5398	56.4
Nature Gas	10^6 m^3	67356	60243	-10.6
Lines Length				
400 kV	km-Circuit	20893	21329	2.1
230 kV	km-Circuit	32411	32571	0.5
132 kV	km-Circuit	23821	23939	0.5
63 & 66 kV	km-Circuit	49524	50205	1.4
Medium Voltage Distribution Lines	km	432082	439308	1.7
Low Voltage Distribution Lines	km	366575	373124	1.8
Substation Capacity				
400 kV	MVA	68763	75008	9.1
230 kV	MVA	85721	88535	3.3
132 kV	MVA	35278	36227	2.7
63 & 66 kV	MVA	75844	78306	3.2
Distribution	MVA	125419	128380	2.4
Total Energy Sale				
A-Domestic Sale	GWh	259723	275094	5.9
Residential	GWh	85099	88500	4.0
Public	GWh	24073	25589	6.3
Agricultural	GWh	38033	38764	1.9
Industrial	GWh	88541	97081	9.6
Others Consumption	GWh	18990	20143	6.1
Street Lights	GWh	4988	5017	0.6
B-Electricity Exchange	GWh	4338	6865	58.3
Customers	1000 Customer	35688	36644	2.7
Residential	1000 Customer	28749	29427	2.4
Public	1000 Customer	1666	1732	4.0
Agricultural	1000 Customer	444	464	4.5
Industrial	1000 Customer	246	255	3.7
Others Consumption	1000 Customer	4583	4766	4.0
Number of Personnel	Person	46408	45446	-2.1
Tavanir Co	Person	673	631	-6.2
REC.s	Person	16066	15479	-3.7
Generation Co.s & Dams	Person	11633	11566	-0.6
Distribution Co.s	Person	16523	16303	-1.3
Others*	Person	1513	1467	-3.0
Electricity Average Sale Price	Rial/kWh	744	809	8.7
Residential	Rial/kWh	612.1	688.1	12.4
Public	Rial/kWh	724.5	882.2	7.0
Agricultural	Rial/kWh	226.5	242.4	7.0
Industrial	Rial/kWh	775	807.9	7.0
Others Consumption	Rial/kWh	2440.3	2611.1	7.0

*By etc., it is meant SATBA Co., Iran Power Plant Repair Co. and Iran Grid Management Co.

Table (11-1) : Specifications of Thermal Power Plants in 2019

Power Plant	Company	Site	Operation Year	No. Units	Nominal Capacity(MW)
A-Steam Power Plants					
Tarasht (shahid Firouzi)	Tehren	Tehren	1959	4	50
Besat	Tehran	Tehran	1967-1968	3	247.5
Islam Abad (Isfahan)	Isfahan	Isfahan	1969	2	75
			1974	1	120
			1980-1988	2	640
Shahid Montazere Ghaem	Private	Karaj	1971-1973	4	625
Loushan(Shahid Beheshti)	Gilan	Loshan	1973	2	240
Zarand	Kerman	Zarand	1973	2	60
Mashhad	Private	Mashhad	1973-1974	2	120
			1968-2007	1	12.5
Zargan	Private	Ahwaz	1975-1992	2	290
Neka (Shahid Salimi)	Mazandaran	Neka	1979-1981	4	1760
			2007	2	19.60
Ahwaz (Ramin)	Khozestan	Ahwaz	1979-1999	6	1890
			2007	2	13
Bandar Abbas	Hormozgan	Bandar Abbas	1980-1986	4	1280
Shahid M. Montazeri	Private	Isfahan	1984-1999	8	1600
			2011-2012	2	16
Toos	Private	Mashhad	1985-1987	4	600
Tabriz	Private	Tabriz	1986-1989	2	736
Shahid Rajaee	Tehran	Ghazvin	1992	4	1000
Bistoon	Gharb	Kermanshah	1994	2	640
Shahid Mofateh	Bakhtar	Hamedan	1994	4	1000
Iranshahr	Sistan & Baluchestan	Iranshahr	1995-97-02-03	4	256
Shazand	Bakhtar	Arak	2000-2001	4	1300
Sahand	Azarbayjan	Tabriz	2004-2005	2	650
Total Steam Plants				79	15240.6

Table (11-2) : Specifications of Gas Power Plants in 2019

Power Plant	Company	Site	Operation Year	No. Units	Nominal Capacity(MW)
B-Gas Power Plants					
Shiraz	Fars	Shiraz	1965	1	11.8
			1967	3	45
			1973	1	28.6
			1974	1	25.6
			1975	1	24.2
			1981	1	60.8
Mashhad	Private	Mashhad	1971-1989	2	37.6
			1977-1978	2	158.0
Bushehr	Fars	Bushehr	1975-1993	2	50.0
Loushan(Shahid Beheshti)	Gilan	Loushan	1977	2	120.0
Doroud	Bakhtar	Doroud	1977	3	90.0
Shahid Zanbagh(Yazd)	Yazd	Yazd	1977-1979	4	97.0
Rey	Tehran	Rey	1977-1978	5	160.0
			1977-87-07	10	237.0
			1978	8	256.0
			1978	3	255.0
			1978	1	24.0
Zargan	Private	Ahvaz	1978-1980	4	128.0
Tabriz (New)	Private	Tabriz	1978	2	64.0
Chahbahar (Konarak)	Sistan & Baloochestan	Chabahar	1978	6	142.5
Orumia	Azarbayjan	Orumia	1981	2	60.0
Shariati	Private	Mashhad	1984-1986	6	150.0
Sufian	Azarbayjan	Tabriz	1984-1985	4	100.0
Zahedan	Sistan & Baloochestan	Zahedan	1986	3	73.4
			1995	1	30.0
			1997	1	24.8
			2007	4	98.0
			1987-1994	1	42.0
Ghaen	Khorasan	Ghaen	1989	3	75.0
Hasa	Esfahan	Shahin Shahr	1995-96-97-02	3	87.6
Kangan	Fars	Kangan	1995	6	150.0
			1998	1	14.0
Yazd	Yazd	Yazd	2002	2	120.0
Farg Darab	Fars	Darab	2002	3	4.2
Bandar Abbas	Hormozgan	Bandar Abbas	2004-2005	2	50.0
Hormozgan (Khalije Fars) C.C	Hormozgan	Bandar Abbas	2005-06-07	6	990.0
Chelsotoon	Khorasan	Isfahan	2005-2006	6	954.0
Roud Shour	Private	Tehran	2005	3	789.0
Orumia C.C	Private	Orumia	2005-2006	4	636.0
Sabalan C.C	Private	Ardebil	2006-2007	2	324.0
			2009	4	636.0
			2006-2007	2	324.0
Kahnodj	Private	Kahnodj	2009	3	75.0
Asaloye	Private	Asaloye	2009-2012	4	636.0
			2006-2007	2	366.0
Ferdosi C.C	Private	Khorasan	2006-2007	6	954.0
Chabahar	Private	Chabahar	2006-2007	4	96.0
			2007	2	318.0
Shahid kaveh C.C (Ghaenat)	Private	Ghaen	2007-2008	4	636.0
Khorramshahr	Private	Khorramshahr	2007-2008	6	972.0
Noshahr	Private	Noshahr	2007-08-09-13	2	47.4
Golestan	Private	Golestan	2008	4	648.0
			2008	2	366.0
Zagros	Private	Kermanshah	2009	4	648.0
Soltanie	Private	Zanjan	2009-2010	4	648.0
Semnan C.C	Private	Semnan	2009-10-11	2	324.0
Bastami (Shahrood)	Semnan	Shahroud	2009	2	324.0
Hafez (Fars)	Private	Fars	2010	6	972.0
Bam Pour	Sistan & Baloochestan	Iranshahr	2010-2011	2	324.0
Esin	Hormozgan	Hormozgan	2012-2014	4	648.0
Eslamabad Gharb	Gharb	Eslamabad	2014	4	100.0
Shams	Private	Sarakhs	2014	3	75.0
Ofogh	Khouzestan	Mahshahr	2016	4	664.0
Parnian	Private	Tehran	2017	1	25.0
noshahr	Mazandaran	Mazandaran	2017	1	25.0
Pasargad	Private	Hormozgan	2017	3	70.0
Behsahr	Mazandaran	Mazandaran	2017	1	25.0
Amirabad	Private	Mazandaran	2017	3	34.0
Caspian	Private	Noshahr	2018	1	307.0
Golbargh	Private	Mako	2018	2	76.0
Delahoo	Private	Kermanshah	2019	1	307.0
Karon	Private	Khozestan	2019	2	340.0
Tarasht	Private	Tehran	2019	1	25.0
Haris	Private	East Azarbaijan	2019	1	310.0
Khoramabad	Private	Khoramabad	2019	1	162.0
DG & CHP	Private	Country	2011-2019	246	1734.0
Total Gas Power Plants in NG				469	21028.5
Kish (Gas)	Kish	Kish	1992-99-2003-2006-2007	3	112.5
				1	24.3
				2	47.0
Khark (Gas)	Fars	Khark	2014	1	25.0
Total Gas power plants out of NG				7	208.8
Total Gas Power Plants				476	21237.2

Table (11-3) : Specifications of Combined - Cycle Power Plants in 2019

Power Plant	Company	Site	Operation Year	No. Units	Nominal Capacity(MW)
C-Combined-Cycle Plants					
Gilan Combined-Cycle	Private	Rasht	1992	6	859.2
			1997	3	446.4
Montazare Ghaem	Private	Karaj	1992	6	697.5
			1999-2000	3	300.0
Qom Combined-Cycle	Private	Qom	1993	4	514.0
			1997-1998	2	200.0
Shahid Rajaee Combined-Cycle	Tehran	Ghazvin	1994	6	742.8
			2001	3	300.0
Neishabour Combined-Cycle	Private	Neishabour	1994-1998	6	740.4
			2002-2003	3	300.0
Shariati Combined-Cycle	Private	Mashad	1994	2	246.8
			2003	1	100.0
Fars Combined-Cycle	Private	Shiraz	1995-1998	6	740.4
			2002	3	294.9
Khuy Combined-Cycle	Private	Khuy	1997	2	246.8
			2002	1	102.5
Shahid Salimi Combined-Cycle	Mazandaran	Neka	2006	1	160.0
			1990	2	275.0
Yazd Combined-Cycle	Yazd	Yazd	2006-2010	2	320.0
			2000	2	246.8
			2008-2009	2	318.0
Kazeroon Combined-Cycle	Private	Kazeroon	1994	2	256.0
			2002-2003	4	636.0
			2006-2007	3	480.0
Kerman Combined-Cycle	Kerman	Kerman	2001-2002	8	1272.0
			2007-2009	4	640.0
Damavand Combined-Cycle	Private	Garmsar	2003-04-05	12	1908.0
			2009-10-11-12	6	960.0
Sanandaj Combined-Cycle	Private	Sanandaj	2005-2006	4	636.0
			2011-2012	2	320.0
Abadan Combined-Cycle	Private	Abadan	2002-2003	4	493.6
			2013-2014	2	320.0
Zavare Combined-Cycle	Private	Esfahan	2011	2	324.0
			2012	1	160.0
Pare Sar Combined-Cycle	Private	Gilan	2011-2012	4	648.0
			2013	2	320.0
Shir kooh Combined-Cycle	Private	Yazd	2012	2	324.0
			2013	1	160.0
Genaveh Combined-Cycle	Private	Boushehr	2011	2	324.0
			2014	1	160.0
Shoobad	Private	Kahnooj	2014	2	324.0
			2016	1	160.0
Chadormaloo	Private	Chadormaloo	2014	2	332.0
			2016	1	160.0
Shirvan	Khorasan	Shirvan	2005-06-07	6	954.0
			2017	2	320.0
Samangan	Private	Kerman	2016	2	332.0
			2017	1	160.0
Taban	Private	Yazd	2015	2	324.0
			2017	1	160.0
Parand	Private	Tehran	2006	3	477.0
			2006 (Optimization 2018)	3	549.0
			2017-2018	2	320.0
Piroozan	Private	Behbahan	2016	2	332.0
			2017	1	160.0
Jahrom	Private	Jahrom	2007-2008	6	954.0
			2017	2	320.0
Kashan	Private	Kashan	2009	2	324.0
			2018	1	160.0
Goharan	Private	Sirjan	2016	2	332.0
			2019	1	160.0
Total Combined-Cycle Plants				177	25315

Table (11- 4) : Specifications of Hydro Power Plants in 2019

Power Plant	Company	Site	Operation Year	No. Units	Nominal Capacity(MW)
D-Large Hydro Power Plants					
Dez Dam	Khozestan	Andimeshk	1962-1971	8	520.0
Shahid Abbaspuor Dam	Khozestan	Masjed Soleyman	1977-2002-03	8	2000.0
Masjed Soleyman Dam	Khozestan	Masjed Soleyman	2002-03-07-08	8	2000.0
Karkheh Dam	Khozestan	Karkheh	2002-2003	3	400.0
Karoune 3 Dam	Khozestan	Masjed Soleyman	2004-05-06	8	2000.0
Karoune 4 Dam	Isfahan	Chahar Mahal	2010-2011	4	1000.0
Gotvand Dam	Khozestan	Masjed Soleyman	2012	4	1000.0
Kalan Dam	Tehran	East Tehran	1988	3	115.5
Simareh	Ilam	Ilam	2015	3	480.0
Mollasadra Dam	Fars	Fars	2007	2	100.0
Siabisheh	Mazandaran	Mazandaran	2013-2014	4	1040.0
Roodbar	Ab Lorestan	Lorestan	2016-2017	2	450.0
Darian	Ab Kermanshah		2017-2018	3	210.0
Sardasht				3	150.0
Total Large Hydro Power Plants				63	11465
E-Medium Hydro Power Plants					
Amir Kabir Dam	Tehran	Karaj	1961	2	90.0
Sefid Rood Dam	Shomal	Mangil	1964	5	87.5
Latyan Dam	Tehran	Latyan	1969-1987	2	45.0
Zayandeh Rood Dam	Isfahan	Isfahan	1970	3	55.5
Aras Dam	Azarbaijan	Jolfa	1973	2	22.0
Jiroft Dam	Kerman	Jiroft	1997	2	32.4
Maroun Dam	Khozestan	Behbahan	2004	2	150.0
Koohrang Dam	Isfahan	Koohrang	2004-2005	3	39.3
Vafarghan Dam	Markazi	Saveh	1996	2	10.4
Taleghan Dam	Tehran	Taleghan	2006	2	18.0
Shoot-e-Moghan Dam	Azarbaijan	Moghan	2002	2	13.0
Takam Dam	Mazandaran	Mazandaran	1989	3	15.0
Lavarak Dam	Tehran	Tehran	2008-09	2	44.0
Total Medium Hydro Power Plants				32	622
F-Small Hydro Power Plants					
Mahabad Dam	West Azarbaijan	Mahabad	1972	2	6.0
Arde (Out of NG)	Gilan	Gilan	1991	1	0.1
Asiabak Dam	Markazi	Saveh	1997	2	5.2
Polkalo 4		Dena	1994	2	2.5
Golab	Isfahan	Golab	1996	1	2.8
Kerik 2		Dena	2006	2	2.5
Kerik 3		Dena	2006	2	3.0
Siram (Out of NG)	Lorestan	Siram	2004	1	0.1
Sarrood (Out of NG)	Khorasan	Sarrood	1987	1	0.1
Dorudzan	Fars	Shiraz	1989	2	10.0
Maran (Out of NG)	Mazandaran	Maran	2004	1	0.04
Khalian (Out of NG)	Gilan	Khalian	2004	1	0.03
Gerni (Out of NG)	Khorasan	Gerni	2004	1	0.03
Nave (Out of NG)	Gilan	Nave	2004	1	0.1
Darjan (Out of NG)	Mazandaran	Darjan	2004	1	0.1
Polkalo2 & Khakhdan	Kohgiloyeh	Dena	2008	2	4.0
			2008	1	0.9
Shahid Talebi (Sepidan)	Fars	Sepidan	1995	3	2.3
Jannat Roodbar (Out of NG)	Mazandaran	Roodbar	1997	2	1.0
Gamasyab	Hamadan	Hamedan	1999	2	2.8
DarrehTakht 2 (Out of NG)	Lorestan	Ezna	2001	2	0.9
Kernekh (Out of NG)	Ardebil	Khalkhal	2002	1	0.1
PolKalo 1		Dena	2004	2	4.0
Darreh Takht 1 (Out of NG)	Lorestan	Ezna	2006	2	0.7
Menj		Chahar Mahal Bakhtiari	2009	2	5.0
Piran	Kermanshah	Kermanshah	2011	2	8.5
Azad	Ab Kordestan	Kordestan	2015	3	10.0
Sad Tarik	Gilan	Rasht	2015	2	3.0
Bijar	Ab Gilan	Gilan	2017	1	6.3
Roshde Sanat	Ab Ghom	Ghom	2017	1	2.7
Parsian	Ab Markazi	Markazi	2017	1	0.2
Pardisan	Ab Lorestan	Borojerd	2017	1	0.2
Sabze Mashhad		Khorasan	2017	1	0.4
Semnan		Semnan	2018	1	3.0
Mahalat	Ab Markazi		2019	5.5&3.5	9.0
Khalagh	Ab Lorestan		2019	0.2	0.2
Sari			2019	1.9	1.9
Rajaei			2019	0.7	0.7
Salsal			2019	1	1.0
Poyesh			2019	2	2.0
Out of Network Small Hydro				15	3
Network Small Hydro				53	101
Total Small Hydro Power Plants				68	104
Total Hydro Power Plants				162.8	12191

Table (11-5) : Specifications of Renewable & Larg Industrial Power Plants in 2019

Power Plant	Company	Site	Operation Year	No. Units	Nominal Capacity(MW)
G- Renewable Energy					
Booshehr		Booshehr	2011	1	1020.0
H- Wind Power Plants					
Manjil (Manjil, RoodbarT Hrzevil, Paskoolan and Siahpoosh atomic energy)	SATBA	Manjil/Roodbar	1994	2	1.00
		Manjil	1997-1998-03	7	3.85
		Manjil	1997-1998	15	4.50
		Roodbar	1995	3	1.65
		Harzvil	1998-2000-2003-2004	12	3.60
		Paskoolan	2003-2004	8	4.40
		Manjil	2002	1	0.66
		Paskoolan	2004-2005	22	14.52
		Manjil	2007	17	11.22
		Manjil	2008	24	15.84
		Manjil	2012	16	10.56
		Manjil	2014	31	20.46
Binalood Khorasan	SATBA	Binalood	2004-2006	20	13.20
			2007	23	15.18
			2008	2	0.26
Zabol Wind Plant		Zabol	2009	1	0.66
Shiraz Wind Plant		Shiraz	2010	1	0.66
Tabriz Wind Plant (oun ben ali)		Tabriz	2009-2010	3	1.98
Mahshahr Wind Plant		Mahshahr	2012	1	0.66
Isfahan Wind Plant		Isfahan	2012	1	0.66
Sarein Wind Plant		Ardebil	2012	1	0.66
Khaf Wind Plant	Behin ertebat-mehr	Khorasan Razavi	2012	2	4.00
Tavan Wind Plant	Tavan Bad Wind Plant	Khorasan Razavi	2015	1	0.80
Takestan Wind Plant	Mapna	Takestan	2016-17	22	55.00
Siahposh Wind Plant	Arian Mahabad	Ghazvin	2017	18	61.20
Atrin Iranian Wind Plant	Artin Iranian	Binalood	2014	2	4.00
Sarab Wind Plant		Sarab	2014	1	0.66
Agha ghand Wind Plant	Mapna	Azarbaijan Sharghi	2017-18	20	50.00
Nir Wind Plant		Nir	2014	1	0.66
Total Wind Power Plants				278	303
I-Solar Power Plant					
Taban Solar PP		Tehran	2017	1	0.02
Tabriz Solar PP		Tabriz	2009	1	0.02
Uroomie Solar PP		Uroomie	2014	1	0.02
Ardebil Solar PP		Ardebil	2014	1	0.02
Parsian Solar PP		Tehran	2015	1	0.51
Zanjan Solar PP		Zanjan	2015	1	0.10
Semnan Solar PP		Semnan	2015	1	0.02
Khalij Fars Solar PP		Hamedan	2016	1	7.00
Amirkabir Solar PP		Hamedan	2016	1	7.00
Shohadeye Hamedan Solar PP		Hamedan	2017	1	7.00
Baba Taher Solar PP		Hamedan	2017	1	8.50
Booali Solar PP		Hamedan	2017	1	8.90
Jerghoye Solar PP		Isafahan	2017	1	10.00
Mahan 1 Solar PP		Kerman	2017	1	10.00
Mahan 2 Solar PP		Kerman	2017	1	10.00
Ardakan Yazd Solar PP		Yazd	2017	1	10.00
Ashkdaz Yazd Solar PP		Yazd	2017	1	10.00
Taybad Solar PP		Khorasan	2017	1	0.31
Zahedan Solar PP		Zahedan	2017	1	10.00
Pakbana Solar PP		Ghom	2017	1	1.00
Tara Moshaver Solar PP		Tehran	2017	1	0.23
Damavand Solar PP		Tehran	2017	1	8.00
Aftabe kavir Solar PP		Khorasan jonobi	2017	1	10.00
SAyare Sabz Solar PP		Kashan	2017	1	1.00
Gheshm Solar PP		Gheshm	2017	1	10.00
Shahre Rey Solar PP		Shahre Rey	2017	1	10.00
Abade Fars Solar PP		Abade	2017	1	10.00
Arvand Solar PP		Kerman	2017	1	1.20
Siman Shahrekord Solar PP		Shahrekord	2017	1	1.50
Abooyand Solar PP		Semnan	2017	1	1.31
Iran Tabloo Solar PP		Karaj	2017	1	0.63
Behnad Energy Solar PP		Fars	2017	1	4.60
Shahr Reza Solar PP		Shahr Reza	2017	1	0.45
Parsian Solar PP		Kaboodar Ahang	2018	1	7.00
Bahar Solar PP		Rey	2018	1	2.50
Ghadir Solar PP		Ghom	2018	1	10.00
Boshroyeh Solar PP		Boshroyeh	2018	1	1.00
Kahak Solar PP		Ghazvin	2018	1	2.00
Baft Solar PP		Kerman	2018	1	10.00
Eghlid Solar PP		Eghlid	2018	1	10.00
Nika Solar PP		Fars	2018	1	10.00
Mahan 3 Solar PP		Mahan	2018	1	10.00
Bardsir 1 Solar PP		Kerman	2018	1	1.00
Bardsir 2 Solar PP		Kerman	2018	1	2.50
Dehshir Solar PP		Yazd	2018	1	3.50
Fahraj Solar PP		Yazd	2018	1	10.00
Chahak Solar PP		Yazd	2018	1	10.00
Nir Solar PP		Yazd	2018	1	5.00
Mehriz Solar PP		Yazd	2019	1	10.00
Arad Solar PP		Ardabil	2019	1	1.00
Goftari Solar PP		Sarbisheh	2019	1	7.00

Table (11-5) : Specifications of Renewable & Larg Industrial Power Plants in 2019

Power Plant	Company	Site	Operation Year	No. Units	Nominal Capacity(MW)
Cheraghi Solar PP		Jarghoyeh	2019	1	0.16
Saba Solar PP		Kerman	2019	1	1.00
Abhar Solar PP		Abhar	2019	1	7.00
Toos Solar PP		Khaf	2019	1	5.00
Sadid Solar PP		Ardakan	2019	1	3.00
Moghadam Solar PP		Ghazvin	2019	1	1.00
Takht-e JamshidSolar PP		Larestan	2019	1	10.00
Farsan Solar PP		Shahrza	2019	1	1.00
Attar Solar PP		Fars	2019	1	10.00
Parto Farayand Solar PP		Lamard	2019	1	10.00
Farhan Kaab Solar PP		Shosh	2019	1	2.00
Faraandishan Solar PP		Fars	2019	1	0.56
Arman Sharif Solar PP		Fars	2019	1	2.00
Taleghani Solar PP		Esfahan	2019	1	1.00
Arak Solar PP		Arak	2019	1	1.00
Photoveltabik			2012-2019		62.00
Total				66	389
K-Other Renewable Energies					
Mashad Waste incineration Energy plant		Mashad	2009	2	0.66
Shiraz Waste incineration Energy plant		Shiraz	2009	2	1.20
Tehran Biogaz Plant		Tehran	2012	1	1.90
Tehran Waste incineration Energy plant		Tehran	2012	1	4.00
Tehran Waste incineration Energy plant (2)		Tehran	2014	1	3.00
Bahabad Waste incineration Heat Recovery Power Plant		Yazd	2017	1	4.00
Dehkhoda Waste incineration Heat Recovery Power Plant		Khoozestan	2017	1	9.60
Sun of Other Renewable Energies				9	24
Total Renewable & Nuclear				354	1735
I - Disel Power Plant					
Total Diesel Power Plants (in NG)				145	409
Total Diesel Power Plants (Out of NG)				24	30
Total Diesel Power Plants				169	439
Total Power Plants (MOE) & Private (in NG)				1287	74161
Total Power Plants (MOE) & Private (out of NG)				46	242
Total Power Plants (MOE) & Private				1411	76652
Large Industrial					
Zobahan (Steam)	Isfahan Zobahan Co.	Isfahan	1970	2	24.0
			1996	1	60.0
			1978	3	165.0
Zobahan (Gas)			1976	1	26.0
Mess Sarcheshmeh (Steam)	Mess Iran Co.	Rafsanjan	1977	2	24.0
Mess Sarcheshmeh (Gas)			1977	5	130.0
Foolad-Mobarake (Steam)	Foolad-Mobarake	Isfahan	1991	3	210.0
Foolad-Mobarake (Gas)		Isfahan	2004	1	108.0
Teraktorsazi (Gas)	Teraktorsazi	Tabriz	1983	2	20.0
Chadormaloo	Chadormaloo	Yazd	2003	1	40.0
Khorasan Petrochimi	Khorasan Petrochimi	Khorasan	1986	3	24.0
Shiraz Petrochimi (Steam)	Shiraz Petrochimi	Shiraz	1963	3	12.6
			1984	1	9.0
			1987	5	60.0
Bandare Emam Petrochimi	Bandare Emam Petrochimi	Bandar Emam	1990-1991	4	328.0
Ilam Gas Refinery	Ilam Gas Refinery	Ilam	2009-2010	3	75.0
Razi Petrochimi	Razi Petrochimi	Bandar Emam	1979	5	70.0
Tabriz Petrochimi	Tabriz Petrochimi	Tabriz	1997	3	75.0
			1995-1996	2	54.0
Fajr Petrochimi	Fajr Petrochimi	Bandar Emam	2005	5	585.0
			2009-2010	4	648.0
			2011	2	250.0
Mobin Petrochimi	Mobin Petrochimi	Asalooyeh	2006-2012	7	861.0
Pars Jonoubi		Asalooyeh	2008-2009	6	954.0
Ilam Petrochimi		Ilam	2010	4	120.0
Liquified Gas (LNG)		Booshehr	2010	2	324.0
Damavand Petrochimi		Asalooyeh	2011-17	4	648.0
Hormoz		Bandarabbas	2018	1	160.0
Total Large Industrial				85	6065
ToTal Country				1496	82717

Table: (12) Time Schedule for Completion of Various New Thermal and Hydro Power Plants

No.	Status	Name of Power Plant	Type of Power Plant	Dispaching Region	2020	2021	2022	2023
1	MOE	Shirvan	C.C	Khorasan	160			
2		Zarand		Kerman		324		
3		Neka		Mazandaran				162
4		Dokohe		Khozestan		307		
5		Sahand		Azarbayjan			307	
6		Ramin Ahvaz		Khozestan			307	
7		Zahedan	Gas	Sistan & Balochestan		42		
8		Anbarabad		Kerman		42		
9		Jask		Hormozgan		42		
10	BOO	Gheshm 2	C.C	Hormozgan	350		160	
11		Caspein		Mazandaran	154			
12		Khoram Abad		Lorestan		160		
13		Dalaho		Kermanshah	310	293		
14		Heris		Azarbayjan	180			
15		West Karoon		Khozestan		160		
16		Aryan		Zanjan		183	363	
17		Sabzevar		Khorasan			180	340
18		Torbat Heydarieh		Khorasan			180	340
19		Jahrom		Fars		160		
20		Uroomieh		Azarbayjan	160	320		
21		Sabalan		Ardebil	160	320		
22		Roodshoor		Tehran			345	
23		Chabahar		Sistan & Balochestan		160		
24		Ferdosi		Khorasan	160	320		
25		Asaloyeh		Booshehr		320		
26		Renewable	Renewable	Different Regional	300	200	200	200
27		DG, CHP	DG ,CHP	Different Regional	300	300	300	300
28	MOE	Sardasht	Hydro	Azarbayjan				
29		Azad		Kordestan		170		
30		Chamshir		Khoozestan	55	121		
31		Hydro P.P (L.S)		Different Regional	4			
Total Nominal Capacity of MOE Power Plants					219	1048	614	162
Total Private Power Plants					2074	2896	1728	1180
Total Nominal Capacity					2293	3944	2342	1342
Total Gathering Nominal Capacity of Country with 83506 Mw in the end of 2019					85799	89743	92085	93427

Table 13: Nominal Capacities of the Power Plants in 2019 (MW)

Type of Power Plant	MOE			non-MOE	Total
	In NG	Out of NG	Total		
Steam	11241	0	11241	4589	15829
Combined Cycle	5549	0	5549	21581	27129
Gas	6527	209	6736	19444	26180
Diesel	410	30	440	0	439
Hydro	12189	3	12192	0	12192
Atomic & Renewable	1119	0	1119	617	1736
Total in 2019	37035	242	37277	46231	83506
Total in 2018	36384	242	36626	43842	80467
Annual Growth %	1.8	0	1.8	5.4	3.8

Difference in total is due to rounding

Table 14 : Actual Capacity of the MOE Power Plants in 2019 (MW)

Type		Steam	C.C	Gas	Diesel	Hydro	Renewable Energy & Wind	Total
Actual Capacity	Max	14556	22315	18044	290	12191	1741	74386
	Min	14248	1950	16028	269	12191	1739	51229
	Average	15241	25807	21237	439	12191	1736	69864

Difference in total is due to rounding

Table 15: Growth of the Capacities of the MOE Power Plants in 2019-2020 (MW)

Name of Power Plants	Unit Type	Installed Capacity (NO.*Unit Capacity)	Description
DG	Gas	349	2019
Renewable	Renewable	110	2019
Hydro	Hydro	16	2019
Jahrom	C.C	160	2019 - May.
Delahoo	Gas	307	2019 - Jun.
west Karoon	Gas	340	2019
Goharan	C.C	160	2019 - Jul.
sardasht	Hydro	150	2019 - Jul. Sep. Oct.
Tarasht	Gas	25	2019 - Jul.
shirvan	C.C	160	2019 - Jul.
Haris	Gas	310	2019 - Aug.
khoramabad	Gas	324	2020 - Feb. Mar.
Parand	C.C	160	2020 - Mar.
Hengam	Gas	307	2020 - Mar.
Asalooyeh	C.C	160	2020 - Mar.
Total		3038	

Table 16 : Comparison of the Modified Monthly Peak Load in between 2018 - 2019 (MW)

Month		Mar-April	April-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-Mar	Peak in the Year	Date of Peak
Year	2019	34638	43614	54139	57681	57377	54377	48635	39074	37838	38198	39201	38384	57681	11 July 2019
	2018	37809	41524	50713	57098	57033	50343	45795	37542	35686	36380	35856	36486	57098	30 July 2018
Change %		-8.4	5.0	6.8	1.0	0.6	8.0	6.2	4.1	6.0	5.0	9.3	5.2	1.0	

Source: Iran Grid Management Co. (IGMC)

Table 17 : Contribution of Various Types of Power Plants in Supply of the Coincide Peak Load during the Years 2009-2019 (MW)

Type	2019		2018		2017		2016		2015		2014		2013		2012		2011		2010		2009	
	Percent	Total	Percent	Total	Percent	Total	Percent	Total	Percent	Total	Percent	Total	Percent	Total	Percent	Total	Percent	Total	Percent	Total	Percent	Total
Steam	22.5	12772	25.4	12354	23.3	12542	24.7	12693	25.6	12538	24.3	11322	27.5	12551	29.5	12755	31.2	13187	35.2	13673	35.9	13505
Gas	25.3	14377	28.8	14015	28.0	15096	30.0	15405	29.3	14334	29.4	13691	28.7	13063	31.7	13724	29.8	12590	28.6	11108	30.9	11606
C.C.	32.7	18608	35.0	17040	29.3	15767	27.9	14329	27.2	13342	26.9	12513	25.4	11573	25.5	11044	24.2	10232	26.3	10218	22.2	8356
Hydro	16.8	9533	7.8	3792	16.8	9068	15.2	7812	15.6	7617	17.0	7894	16.0	7335	13.1	5626	14.6	6170	9.6	3742	10.6	3967
Atomic	1.7	957	2.1	1023	1.9	1008	2.0	1006	2.1	1012	2.1	1000	2.2	996	-	-	-	-	-	-	-	-
Diesel	1.0	549	0.9	436	0.7	361	0.4	188	0.3	130	0.3	138	0.2	92	0.2	94	0.2	66	0.4	150	0.4	146
Total	100.0	56856	100.0	48659	100.0	53842	100.0	51432	100.0	48973	100.0	46558	100.0	45610	100.0	43243	100.0	42245	100.0	38891	100.0	37580

Table 18 : Coincide Max.Peak Load Synchronous with Available and Actual Capacity on One Day in the Year 2019-2020 (MW)

Year / Month	Date	Effective Capacity	Available Capacity	Max Demand	Generation Reserve(%)
2019 April	11	65785	45131	34638	23.3%
2019 May	21	63817	48265	43614	9.6%
2019 Jun.	20	62821	49307	54139	9.8%-
2019 Jul.	11	63186	50286	57681	14.7%-
2019 Jul.	28	63248	49883	57377	15.0%-
2019 Aug.	25	63365	58433	54377	6.9%
2019 Sep.	23	64096	50929	48635	4.5%
2019 Oct.	23	66725	47632	39074	18.0%
2019 Dec.	18	67513	45517	37838	16.9%
2020 Jan.	13	67612	44227	38198	13.6%
2020 Feb.	19	67757	49359	39201	20.6%
2020 March	9	68180	42429	38384	9.5%

Source: Iran Grid Management Co. (IGMC)

Table 19: Coincide Min. Load Synchronous with Available and Actual Capacity on One Day in the Year 2019-2020 (MW)

Year / Month	Date	Actual Capacity	Available Capacity	Min Demand	Generation Reserve (%)
2019 April	2	65874	47793	23289	51.3 %
2019 May	11	65619	45559	29156	36.0 %
2019 May	25	64606	50340	39603	21.3 %
2019 June	22	62356	52246	49241	5.8 %
2019 Agust	22	62860	53427	47632	10.8 %
2019 Sep.	20	63919	51924	37094	28.6 %
2019 Oct.	22	64925	46103	33811	26.7 %
2019 Nov.	30	66186	42516	29487	30.6 %
2019 Nov.	30	66819	43309	28999	33.0 %
2020 Jan.	18	67386	42541	29556	30.5 %
2020 Feb.	1	67165	35035	30129	14.0 %
2020 Mar.	20	67663	48636	27895	42.6 %

Source: Iran Grid Management Co. (IGMC)

Table 20: Annual Growth Trend of the Peak Generation Load; Modified Consumption Demand and Max. Consumption Load during the Years 2009-2019 (MW)											
Description	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009
Consumption Load	8052	-5577	2448	2796	2517	1018	2342	1092	2926	1869	3545
Corrected Consumption Demand	582	1656	2750	2864	1380	2453	3015	1092	2128	2361	227
Maximum Generation Load	8196	-5184	2411	2463	2414	1041	2416	998	3354	1311	3310

Table 21 : Gross Electricity Generation in 2019 (GWh)					
Type	2019			2018	Annual Growth (%)
	In NG	Out of NG	Total	Total	
Steam	85115	0	85115	85655	-0.6
Gas	70375	841	71216	70320	1.3
C.C.	131149	0	131149	129201	1.5
Hydro	31081	1	31082	15765	97.2
Diesel	10	30	39	81	-51.4
Atomic & Renewable	7828	0	7828	8160	-4.1
Total	325558	872	326430	309182	5.6

Table 22 : Gross Generation and Internal Consumption in the MOE Power Plants in 2019 (GWh)			
Type	Gross Generation	Internal Consumption	
		Quantity	Percent
Steam	85655	5979	7.0
Combined Cycle	129201	2258	1.7
Gas	70320	373	0.5
Diesel	81	6	7.4
Hydro	15765	87	0.6
Atomic & Renewabal Energy	8160	0	0
Total	309182	8703	3

Table 23 : The Growth Trend of the Electricity Generation Per Capita during the Years 2009-2019 (GWh)											
	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009
Annual Energy Generation (GWh)	326431	309182	307968	289196	280689	274480	262192	254265	240063	232994	221318
Population (10^6 Person)	83.8	82.8	81.8	80.8	79.3	78.3	77.4	76.5	75.3	73.6	72.6
Annual Generation per Capita (KWh)	3896	3735	3765	3578	3542	3505	3387	3325	3188	3166	3048

Table 24 : Balance of Electricity Generation and Consumption in 2019 (GWh)

Description		Total
Generation	MOE	144068
	Non-MOE	182362
	Total	326430
Import		1341
Total Generation & Import		327771
Consumption & Sale	Internal Consumption of MOE Plants	8871
	Internal Consumption of Substations	280
	Large Industry Consumption	2770
	Transmission & Sub-Transmission Losses	8690
	Distribution Losses	23860
	Export	8206
	Sale	275094
Total Consumption		327771

Difference in total is due to rounding.

Table 25 : Losses in the Electric National Grid Compared with Net Generation in 2019 (GWh)

Description	Quantity	%
Net Generation	138359	-
Electricity Delivered to Distribution Network	244497	-
Transmission & Sub-Transmission Loss	8690	2.76
Distribution Loss	23860	9.76
Total Loss	32550	10.32

Table 26 : Consumption of the Various Fuel Types in Power Plants in 2019 and its Comparison with 2018

Type	Description	MOE Power Plants				Total		Change (%)
		Steam	C.C.	Gas	Diesel	2019	2018	
Diesel 10^6 Liter Equivalent	Consumption	172	5297	4772	12	10253	5970	71.7
	Percent Out of Total	1.7	51.7	46.5	0.1			
	Average Daily	0.5	14.5	13.1	0.0	28.1	16.4	
	Thermal Value (10^9 Kcal) Consumption	1467	46815	39931	101	88314	51334	
Fuel Oil 10^6 Liter	Consumption	5398				5398	3451	56.4
	Percent Out of Total	100.0	0.0	0.0	0.0			
	Average Daily	14.8	0.0	0.0	0.0	14.8	9.5	
	Thermal Value (10^9 Kcal)	50460				50460	32246	
Natural Gas 10^6 M^3	Consumption	17686	24238	18320	0	60244	67356	-10.6
	Percent Out of Total	29.4	40.2	30.4	0.0			
	Average Daily	48.5	66.4	50.2	0.0	165.1	184.5	
	Thermal Value (10^9 Kcal)	148264	209666	144620	0	502550	560487	

Table 27-1 : Length of Transmission and Sub-Transmission Lines at the end of 2018 and 2019 km-Circuit

Description	400kv	230kv	132kv	63,66kv	Fiber-Optic
Total Line Length in 2018	20893	32411.1	23821	49524	26694
Establishment Completion of New Line in 2019	436	160	118	681	139
Total Line Length in 2019	21329	32571	23939	50205	26833
Annual Growth (%)	2.1	0.5	0.5	1.4	0.5

Table 27-2: Transmission and Sub-Transmission Networks Overhead and Underground Lines by the end of 2019.

Description	400 kV		230 kV		132 kV		63 and 66 kV		Optical Fiber Network	
	No.	KM Circuit	No.	KM Circuit	No.	KM Circuit	No.	KM Circuit	No.	KM Circuit
Overhead	257	21329	593	32498	725	23858	2089	48494	3664	126179
Underground	0	0	16	73	24	81	438	1711	478	1865
Total	257	21329	609	32571	749	23939	2527	50205	4142	128044

Table 28 : Statistical Comparison of the Number and Capacity of Transmission Substations of 400 kV at the end of 2018 & 2019

Description	No. Stations		No. Transformers		Capacity (MVA)	
	2019	2018	2019	2018	2019	2018
400/230/...	58	56	135	130	43460	41625
400/132/...	40	38	77	65	16015	13600
400/66,400/63	22	23	54	50	10650	9850
400/11,400/20,400/33	12	5	30	15	4703	2448
Switchyards	23	14	0	0	0	0
Total	155	144	296	266	75008	68763
Annual Growth (%)	7.6		11.3		9.1	

Table 29 : Statistical Comparison of the Number and Capacity of Transmission Substations of 230 kV at the end of 2018 & 2019

Description	No. Stations		No. Transformers		Capacity (MVA)	
	2019	2018	2019	2018	2019	2018
230/132-20	53	61	127	127	16800	16600
230/63-66	202	215	442	435	59524	57930
230/33/11	32	39	96	82	7589	6019
230/20	21	29	58	54	4362	4067
230/11-6.6	1	3	5	5	260	260
Switch Board	19	11	0	0	0	0
Total	328	320	728	710	88535	85721
Annual Growth (%)	2.5		2.5		3.3	

Table 30 : Statistical Comparison of the Number and Capacity of Sub-Transmission Substations at the end of 2018 & 2019

Description		No. Stations		No. Transformers		Capacity (MVA)	
		2019	2018	2019	2018	2019	2018
132kV	132/63	19	17	36	33	1795	1645
	132/33	151	134	313	275	10555	9210
	132/20	351	367	674	639	20413	19050
	132/11	24	47	84	86	2253	2330
	With Secondary Voltage of less 10 kv	22	20	47	42	1211	1086
	Total	571	556	1154	1127	36227	35278
	Annual Growth (%)	2.7		2.4		2.7	
63,66kV	63/33 & 66/33	2	2	3	3	68	68
	63/20 & 66/20	1329	1342	2567	2510	74105	71546
	63/11-20 & 66/11 - 20 63/10 & 66/10	24	27	52	52	1482	1472
	With Secondary Voltage of less 10 kv	70	68	136	131	2651	2534
	Total	1425	1397	2758	2705	78306	75844
	Annual Growth (%)	2.0		2.0		3.2	
	Total	1996	1953	3912	3832	114533	111122
	Annual Growth (%)	2.2		2.1		3.1	

Table 31: Transmission and Sub-Transmission Network by Private and GIS Type by the end of 2019

Description	GIS Substations Capacity (MVA)	Private Substations Capacity (MVA)	Private Lines Lenght (KM Circuit)
400kV	2000	11198	290
230 kV	4035	9782	498
132 kV	1420	5567	1168
63 and 66 kV	2552	10325	3759
Total	10007	36872	5715
Percent of the Whole	3.6 %	13.3 %	4.5 %

It is worth mentioning that by the end of 2018, 126649 KM Circuit and 261339 MVA substations are being operated

Table 32-1: Length of the Medium-Voltage Lines at the end of the Years 2009 - 2019 (kM)

Year	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	Growth in 2018 (%)	Average Annual Growth (%)
Overhead Lines	418135	411320	404628	396959	387638	379707	371667	363651	356495	348039	336985	1.7	2.2
Under Ground Lines	21174	20763	20206	20054	19335	18751	17898	17277	16524	15662	14928	2.0	3.6
Total	439309	432083	424834	417013	406973	398458	389565	380928	373019	363701	351913	1.7	2.2

Table 32-2: Length of the Low-Voltage Lines at the end of the Years 2009 - 2019 (kM)

Year	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	Growth in 2018 (%)	Average Annual Growth (%)
Overhead Lines	321570	315874	312591	306192	299036	291401	282554	271052	264900	258635	250162	1.8	2.5
Under Ground Lines	51554	50701	48757	47458	45774	43948	43314	42762	40791	39190	37374	1.7	3.3
Total	373124	366575	361348	353650	344810	335349	325868	313814	305691	297825	287536	1.8	2.6

Table 33 : Statistical Comparison of Distribution Substations at the end of the Years 2009 - 2019

Year	Overhead Substation		Ground Substation		Total Substations		Average Capacity (kVA)
	No. of Units	Capacity (MVA)	No. of Units	Capacity (MVA)	No. of Units	Capacity (MVA)	
2009	420101	60508	28433	21140	448534	77017	172
2010	449481	64824	29617	21993	479098	81648	170
2011	482333	69050	30637	22824	512970	86817	169
2012	508108	72041	31797	23488	539905	91874	170
2013	537500	76459	32989	24419	570489	100878	177
2014	565839	80414	35043	25871	600882	106285	177
2015	593876	84015	36343	26766	630219	110781	176
2016	623852	87985	37870	27784	661722	115769	175
2017	661088	92815	39744	29400	700832	122214	174
2018	684838	95964	40130	29455	724968	125419	173
2019	706683	98577	40658	29803	747341	128380	172
Growth in 2019 (%)	3.2	2.7	1.3	1.2	3.1	2.4	
Average Annual Growth 2009 - 2019 (%)	5.3	5.0	3.6	3.5	5.2	5.2	

Table 34: Some of the Distribution Electric Information at the end of the Years 2009 - 2019

Year	No. of Customers (10^3 Customers)	Max. Demand (MW)	Electricity Delivered to Distribution Network (GWh)	Consumption (GWh)	Distribution Loss (%)	EENS Rate (per 10^3)	Non-Distributed Distribution Energy Ratio (Units per Thousand)	Power Cut Customer (Min/Day)
2009	24191	37878	169280	168438	16	337	2.0	2.86
2010	25698	40239	179329	184182	14.8	348	1.9	2.76
2011	27165	42367	177798	183905	14.7	354	1.9	2.85
2012	28752	43459	187154	194148	15.03	293	1.5	2.6
2013	30287	46474	195050	203215	14.83	293	1.4	2.5
2014	31672	48937	205102	219814	12.93	383	1.7	2.4
2015	32831	50321	214417	227790	11.93	341	1.5	2.2
2016	33824	53198	221920	237560	11.54	290	1.5	1.9
2017	34635	55616	234323	254953	10.97	268	1.3	1.7
2018	35688	57270	234905	259723	10.41	263	1.3	1.6
2019	36644	57861	244497	275094	10.32	255	1.2	1.5
Average Annual Growth 2009-2019 (%)	4.2	4.3	3.7	5.0	-0.57	-2.7	-5.4	-6.2

Table 35 : Trend of Changes of the Number of Customers in Various Consuming Sectors at the end of the Years 2009 - 2019

(1000 customers)

Description	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009
Residential	29427	28749	27994	27354	26620	25739	24670	23467	22224	21048	19844
Public	1732	1666	1595	1543	1465	1382	1283	1181	1083	1005	952
Agricultural	464	444	422	400	378	353	330	307	285	258	202
Industrial	255	246	236	225	217	206	194	185	174	159	161
Others Consumption	4766	4583	4388	4301	4152	3992	3810	3611	3400	3223	3031
Street Lighting*	221*	216*	215*	186*	162*	143*	128*	118*	112*	98*	81*
Total	36644	35688	34635	33824	32831	31672	30287	28752	27165	25693	24191

* No Included in Total

Table 36 : Trend of Energy Consumption in Various Consuming Sectors at the end of the Years 2009 - 2019

(GWH)

Description	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009
Residential	88500	85099	83403	78378	76103	71163	64379	61351	56774	60908	55630
Public	25589	24073	24328	22914	22196	19767	17833	17810	16751	21308	21827
Agricultural	38764	38033	39379	36222	36089	35188	33126	31647	30020	24189	21405
Industrial	97081	88541	84145	77727	72705	74456	70733	67107	63944	61483	54887
Others Consumption	20143	18990	18681	17620	16680	15404	13378	12599	12664	12727	11015
Street Lighting	5017	4988	5017	4699	4017	3837	3765	3635	3752	3568	3674
Total	275094	259723	254953	237560	227790	219815	203214	194148	183905	184182	168438

Table 37 : Average Rate of Electricity Sales to Various Consuming Sectors based on Current Price During Years 2009 - 2019

(Rial / kWh)

Year	Residential	Public	Agricultural	Industrial	Others	Total Average
2009	129.0	152.0	21.0	206.0	501.0	165.0
2010	142.3	226.5	46.8	263.6	599.1	208.7
2011	334.8	501.6	125.7	441.9	1275.3	409.5
2012	337.5	491.0	131.1	427.5	1339.5	407.0
2013	346.8	516.3	133.4	442.6	1342.2	418.5
2014	439.4	617.6	177.9	542.6	1664	525.6
2015	504.7	717.6	195.5	633.2	2046.8	614.7
2016	538.4	765.4	208.5	675.4	2183.2	662.0
2017	555.2	789.4	215.1	696.5	2251.5	682.7
2018	612.1	724.5	226.5	755	2440.3	744
2019	675	879	258	819	2605	816
Average Annual Growth 2009-2019(%)	18.0	19.2	28.5	14.8	17.9	17.3

Table 38 : Average Rate of Electricity Sales to Various Consuming Sectors based on Constant Price of 2011 at the end of the Years 2009 - 2019

(Rial / kWh)

Year	Residential	Public	Agricultural	Industrial	Others	Average	Inflation Indices
2009	176.2	207.6	28.7	281.3	684.1	225.3	73.2
2010	172.9	275.1	56.9	320.2	727.7	253.5	82.3
2011	334.8	501.6	125.7	441.9	1275.3	409.5	100.0
2012	258.6	376.3	100.5	327.6	1026.4	311.9	130.5
2013	197.1	293.5	75.8	251.6	763	237.9	175.9
2014	218.83	307.57	88.58	270.21	828.67	261.77	200.8
2015	221.85	315.43	85.93	278.33	899.68	270.21	227.5
2016	217.08	308.65	84.09	272.34	880.34	266.95	248.0
2017	204.26	290.41	79.12	256.25	828.33	251.18	271.8
2018	195.8	263.8	72.5	241.6	780.7	238.0	312.6
2019	163.1	209.1	57.4	191.5	618.8	191.7	422.0
Average Annual Growth 2009-2019(%)	-0.8	0.1	7.2	-3.8	-1.0	-1.6	

Table 39 : Education profile of the Power industry personnel at the end of the years 2009 - 2019

Year		Degree				
		Below Diploma	High School Bac	University	BA/BS & Higher	Total
2009	Person	10797	7831	10881	14131	43640
	%	24.7	17.9	24.9	32.4	
2010	Person	9403	7370	10081	14857	41711
	%	22.5	17.7	24.2	35.6	
2011	Person	8865	10277	13437	16870	49449
	%	17.9	20.8	27.2	34.1	
2012	Person	6863	9453	12285	18523	47124
	%	15	20	26	39	
2013	Person	5584	9341	11516	20606	47047
	%	12	20	24	44	
2014	Person	4568	8930	10551	22151	46200
	%	10	19	23	48	
2015	Person	3933	8230	8939	24316	45418
	%	9	18	20	53	
2016	Person	3463	7696	8051	27370	46748
	%	7	17	17	59	
2017	Person	3109	7114	7435	28682	46340
	%	7	15	16	62	
2018	Person	2954	6824	6911	29719	46408
	%	6	15	15	64	
2019	Person	2529	6418	6274	30225	45446
	%	6	14	14	66	

Table 40 : The Quantitative changes of the work force in the Main Body of the Electric Power Industry at the end of the years 2009-2019

Person

Instiution	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009
Tavanir Co.	631	673	793	733	881	823	882	905	921	580	610
Thermal P.P	427	440	453	459							
REC.S	15479	16066	16646	16742	17597	17675	17985	17147	17794	9895	10555
Generation Co.s & Dams	11566	11633	10715	10549	9999	9846	10249	10110	10425	10366	10605
Distribution Co.	16303	16523	16653	17201	15940	16441	16499	17564	18893	18922	19962
Others	1040	1073	1080	1064	1071	1415	1432	1398	1416	1948	1908
Total	45446	46408	46340	46748	45418	46200	47047	47124	49449	41711	43640

Other Companies include SATBA (SUNA, SABA) & Iran Power Plant Rapairs Co.

Table 41 : Number of the Power Industry Personnel in Respect to Various Factors at the end of 2019

Person

	Categories	Tavanir	Thermal P.P	RECs	Power Generation	Generation Co.	Distribution Co.	Other Companies	Hydro Power	Total
Year of Service	0-5	71	70	864	114	8481	337	90	2971	4432
	6-10	238	85	5954			3341	302		9920
	11-15	86	93	3481			2476	284		6420
	16-20	73	77	2425			3120	169		5864
	21-25	58	53	1251			2536	138		4036
	26-30	77	34	1191			1350	41		2693
	30&More	28	15	313			143	16		515
	Total	631	47	15479	114	8481	16303	1040	2971	45446
Rank	1-5	39	27	350	114	8481	16303	8	2971	424
	6 -10	319	222	3314				380		4235
	11-15	116	78	1805				120		2119
	16 -20	12	3	67				7		89
	Others	145	97	9943				525		38579
	Total	631	427	15479	114	8481	16303	1040	2971	45446

Other Companies include SATBA (SUNA, SABA) & Iran Power Plant Rapairs Co.

Table 42: The Number of Electric Power Industry Employees by Company in 2019.

Person

Tavanir Co.	No.	Regional Electric Power Co.	No.	Hydro Electric Power Plant	No.	Electric Power Distribution Co.	No.
Managing Director	172	Managing Director	3610	Managing Director	85	Managing Director	1263
Distribution Coordination Deputy	58	Human Resources	588	Power Plant Director	129	Operation and Dispatching	5609
Planning and Economic Affairs	44	Financial and Logistics Deputy	1517	Engineering and Planning Affairs	128	Planning and Engineering	2568
Transmission Coordination Deputy	47	Planning and Researches	602	Technical Support	92	Sale and Services	2988
Financial and Logistics Coordination Deputy and General Assemblies	191	Plan and Development	734	Operation	668	Financial and Logistics	2929
Researches and Human Resources deputy	119	Transmission and Operation	8428	Chemical	160	Human Resources	946
				Transmission	41		
				Repair and Maintenance	498		
				Logistics, Official, Technical and Commercial Affairs	343		
				Security	487		
				Others	340		
Total	631	Total	15479	Total	2971	Total	16303

Table 43 : A Glance at the Statistics of the Global Electricity (2018)

Description	Installed Capacity (1000 MW)					Net Electricity Generation	Electricity Consumption	Population (10^6 Person)	Net Per Capita Electricity Generation (kWh)	Net Per Capita Electricity Consumption (kWh)
	Thermal Plants	Nuclear Plants	Hydro Plants	Rene-wable Plants	Total	(10^9 kWh)				
Former U.S.S.R	276.9	40.7	78.6	5.6	401.8	1497.2	1314.3	289.9	5165.2	4534.2
Europe	475.8	121.5	243.2	363.2	1203.7	3695.8	3441.8	627.4	5891.0	5486.1
N. America	835.4	114.5	196.4	193.0	1339.3	5164.0	4863.5	490.1	10536.0	9922.9
Asia & Oceania	2034.5	86.0	543.6	568.1	3232.3	11798.9	10995.2	4179.7	2822.9	2630.6
S&C. America	133.3	3.5	178.0	47.9	362.7	1290.1	1089.1	515.7	2501.6	2111.9
Africa	169.6	1.9	36.2	13.9	221.6	796.5	678.2	1275.6	624.4	531.7
Middel East	287.6	0.9	16.6	4.1	309.3	1155.4	1016.3	255.7	4519.1	3975.1
World	4213.1	369.1	1292.5	1195.9	7070.7	25398.0	23398.4	7634.0	3326.9	3065.0
Iran	66.8	1	12.0	0.6	80.4	301	259	83	3735	3137
Iran's World Share	1.6	0.3	0.9	0.1	1.1	1.2	1.1	1.1		

Source: www.eia.doe.gov

Table 44-1: Summary of the Electricity Situation in the Major Developing Countries at the end of 2017

Country	Population (10^6 Person)	Installed Capacity (10^3 MW)	Net Electricity Generation (10^9 kWh)	Consumption (10^9 kWh)	Export (10^9 kWh)	Import (10^9 kWh)	Per Capita Capacity (W)	Per Capita Generation (kWh)	Per Capita Consumption (kWh)	Operation Indices (%)
China	1422	1794	6266	5935	19.5	7.6	1262	4407	4174	39.9
India	1341	388	1438	1177	7.2	5.6	289	1072	877	42.3
Brazil	208	157	578	516	0.2	36.5	756	2778	2482	42.0
South Korea	51	123	531	512	0.0	0.0	2410	10404	10035	49.3
Mexico	125	74	305	262	5.8	6.1	594	2441	2092	46.9
Iran	82	79	299	255	8.2	3.8	945	3578	2937	43.2
Turkey	81	85	283	248	3.3	2.7	1052	3495	3060	37.9
Saudi Arabia	33	89	327	295	0.0	0.0	2697	9909	8927	41.9
Thailand	69	46	177	189	1.1	24.5	662	2567	2732	44.2
Indonesia	265	63	241	21	0.0	1.1	236	911	834	44.0
Egypt	96	55	182	159	0.3	0.1	574	1899	1658	37.8
Pakistan	208	34	126	106	0.0	0.6	163	606	507	42.3

Source: www.eia.doe.gov

Table 44-2: Summary of the Electricity Situation in the Major Developing Countries at the end of 2018

Country	Population (10^6 Person)	Installed Capacity (10^3 MW)	Net Electricity Generation (10^9 kWh)	Consumption (10^9 kWh)	Export (10^9 kWh)	Import (10^9 kWh)	Per Capita Capacity (W)	Per Capita Generation (kWh)	Per Capita Consumption (kWh)	Operation Indices (%)	Annual Growth of Per Capita Net Generation (%)
China	1438	1911	6802	6453	21.0	6.9	1329	4729	4487	40.6	7.3%
India	1354	411	1551	1277	8.5	4.7	304	1145	943	43.0	6.8%
Brazil	210	163	592	529	0.0	35.0	777	2822	2521	41.4	1.6%
South Korea	51	128	553	535	0.0	0.0	2504	10804	10448	49.3	3.8%
Mexico	126	77	318	271	6.8	6.5	609	2517	2142	47.1	3.1%
Iran	83	80	301	259	6.3	2.6	964	3765	3117	42.9	5.2%
Turkey	82	89	290	258	3.1	2.5	1074	3523	3131	37.5	0.8%
Saudi Arabia	37	86	356	322	0.0	0.0	2319	9643	8745	47.5	2.7%-
Thailand	69	49	173	186	1.0	26.7	701	2492	2677	40.6	2.9%-
Indonesia	268	66	269	249	0.0	1.5	246	1005	929	46.7	10.4%
Egypt	98	56	185	151	0.5	0.1	569	1875	1530	37.6	1.3%-
Pakistan	212	35	144	121	0.0	0.6	165	678	568	46.8	11.9%

Source: www.eia.doe.gov

Table 45: Time Schedual of Entering the final Thermal & Hydro Elec. Power Plants in being Constracted by Gov. &non Gov. Sec.

(MW)

Power Plant Type		2020	2021	2022	2023
C.C	Gov.	160	631	614	162
	Non Gov.	1474	2396	1228	680
Steam	Gov.	0	126	0	0
Hydro	Gov.	59	291	0	0
Renewable Energy	Non Gov.	300	200	200	200
DG, CHP	Non Gov.	300	300	300	300
Total Gov.		219	1048	614	162
Total non Gov.		2074	2896	1728	1180
Grand Total		2293	3944	2342	1342
Cumulative Sum. Gov. & non Gov.Increasing Capacity		2293	6237	8579	9921
Total Nominal Capacity		85799	89743	92085	93427

At the End of the Year of 2019. County Nominal Capacity Was 83506 MW.

Table 46: Export of Engineering services and equipment to Forein Countries SUNIR CO. from the beginning up to end of 2019

(10^9 Rials)

Country	Contact Signing Year	Contact Price	Incom by End of 2018 (Approved Invoice)	Incom During 2019	Incom by End of 2019
Armenia	2012	4732	1430	466	1896
Iraq	2007	1901	1579	0	1579
Srilanka	2010	1290	1377	0	1377
Pakistan	2008	212	212	0	212
Pakistan	2008	287	287	0	287
Iraq	2012	2313	1759	35	1794
Pakistan	2013	2213	786	0	786
Afghanistan	2011	383	346	0	346
Pakistan	2012	355	352	0	352
Iraq	2013	160	145	0	145
Iraq	2014	326	182	18	200
Syria	2014	2741	1697	0	1697
Ethiopia	2014	110	103	7	110
Turkmenistan	2013	85	85	0	85
Ethiopia	2008	177	177	0	177
Afghanistan	2012	24	24	0	24
Iraq	2014	300	4	0	4
Iraq	2015	13	13	0	13
Syria	2015	87	24	0	24
Ozbakestan	2016	381	49	0	49
Tanzania	2016	136	65	55	120
Total		18031	10696	581	11277

Table 47: Statistical Comparison of the Electricity Indices of 40 Top Countries in the Year 2018

No.	Country	Population (10^6 person)	Installed Capacity (GW)	Net Electricity Generation (10^9 Kwh)	Net Electricity Consumption (10^9 Kwh)	Electricity Exports (10^9 Kwh)	Electricity Imports (10^9 Kwh)	Capacity per Capita (Watt)	Net Generation per Capita (Kwh)	Consumption per Capita (Kwh)	Operation Index (%)
1	China	1438	1911	6802	6453	21.0	6.9	1329	4729	4487	40.6
2	United States	327	1114	4208	4033	13.8	58.3	3411	12882	12346	43.1
3	India	1354	411	1551	1277	8.5	4.7	304	1145	943	43.0
4	Japan	127	316	985	940	0.0	0.0	2476	7725	7372	35.6
5	Russia	146	273	1045	929	17.7	5.2	1870	7170	6376	43.8
6	Germany	83	228	609	533	80.5	31.7	2748	7338	6429	30.5
7	Brazil	210	163	592	529	0.0	35.0	777	2822	2521	41.4
8	Canada	37	148	637	559	51.5	7.3	3994	17218	15102	49.2
9	France	67	134	551	450	76.5	13.6	1993	8230	6713	47.1
10	Korea,South	51	128	553	535	0.0	0.0	2504	10804	10448	49.3
11	Italy	60	115	276	302	3.3	47.2	1907	4564	4993	27.3
12	United Kingdom	66	108	315	307	2.2	21.3	1623	4735	4623	33.3
13	Spain	47	104	260	245	12.9	24.0	2214	5545	5240	28.6
14	Turkey	82	89	290	258	3.1	2.5	1074	3523	3131	37.5
15	Saudi Arabia	37	86	356	322	0.0	0.0	2319	9643	8745	47.5
16	Iran	83	80	301	259	6.3	2.6	972	3735	3137	42.6
17	Mexico	126	77	318	271	6.8	6.5	609	2517	2142	47.1
18	Australia	25	72	248	234	0.0	0.0	2876	9894	9359	39.3
19	Indonesia	268	66	269	249	0.0	1.5	246	1005	929	46.7
20	Egypt	98	56	185	151	0.5	0.1	569	1875	1530	37.6
21	South Africa	58	53	235	207	14.5	8.3	923	4067	3568	50.3
22	Taiwan	24	52	257	247	0.0	0.0	2209	10877	10487	56.2
23	Ukraine	42	52	150	127	6.1	0.0	1227	3560	3013	33.1
24	Thailand	69	49	173	186	1.0	26.7	701	2492	2677	40.6
25	Poland	38	43	160	157	8.1	13.8	1132	4216	4132	42.5
26	Sweden	10	41	158	130	29.4	12.2	4044	15517	12788	43.8
27	Argentina	44	39	139	125	0.3	9.8	869	3132	2815	41.1
28	Norway	5	35	145	126	18.5	8.3	6659	27239	23627	46.7
29	Pakistan	212	35	144	121	0.0	0.6	165	678	568	46.8
30	Netherlands	17	35	109	112	18.8	26.8	2030	6315	6466	35.5
31	Malaysia	32	35	160	147	1.0	0.0	1108	5065	4654	52.2
32	Venezuela	29	33	97	65	1.0	0.0	1142	3358	2250	33.6
33	U.Arab Emirates	10	31	128	120	0.5	0.5	3226	13268	12397	46.9
34	Austria	9	26	60	66	19.1	28.1	2882	6789	7408	26.9
35	Romania	19	24	62	52	6.2	3.7	1213	3166	2672	29.8
36	Belgium	11	23	70	83	4.3	21.6	1994	6113	7294	35.0
37	Kazakhstan	18	23	102	92	5.0	1.6	1229	5554	5008	51.6
38	Switzerland	9	22	64	58	32.6	31.0	2586	7455	6776	32.9
39	Czech Republic	11	22	82	64	25.5	11.6	2059	7720	6009	42.8
40	Portugal	10	21	56	48	8.3	5.7	2062	5456	4707	30.2

Source: www.eia.doe.gov
According to Annual Report 2019-2020

	Iran	84	84	318	275	8.2	1.3	997	3896	3283	43.4

Table 48: Ranking of 40 Countries in Respect to Various Indices in 2018 Grade

No.	Country	Population	Installed Capacity	Net Electricity Generation	Net Electricity Consumption	Electricity Exports	Electricity Imports	Capacity per Capita	Net Generation per Capita	Consumption per Capita	Operation Index
1	China	1	1	1	1	7	20	23	24	25	23
2	United States	3	2	2	2	13	1	4	5	5	16
3	India	2	3	3	3	15	24	38	38	38	17
4	Japan	8	4	5	4	33	35	11	11	11	28
5	Russia	7	5	4	5	11	23	21	15	17	15
6	Germany	11	6	7	8	1	4	8	14	16	35
7	Brazil	6	7	8	9	34	3	34	34	34	21
8	Canada	24	8	6	6	3	19	3	2	2	6
9	France	15	9	10	10	2	13	19	10	14	9
10	Korea,South	19	10	9	7	35	36	10	7	7	5
11	Italy	17	11	16	13	24	2	20	25	21	39
12	United Kingdom	16	12	13	12	26	11	22	23	24	32
13	Spain	20	13	18	19	14	9	13	20	19	38
14	Turkey	12	14	15	16	25	27	30	30	29	27
15	Saudi Arabia	25	15	11	11	37	38	12	9	9	7
16	Iran	13	16	14	15	19	26	31	28	28	19
17	Mexico	9	17	12	14	18	21	36	35	36	8
18	Australia	28	18	20	20	36	37	7	8	8	25
19	Indonesia	4	19	17	17	39	29	39	39	39	13
20	Egypt	10	20	22	24	30	32	37	37	37	26
21	South Africa	18	21	21	21	12	17	32	27	27	4
22	Taiwan	29	22	19	18	38	39	14	6	6	1
23	Ukraine	22	23	27	27	21	33	25	29	30	33
24	Thailand	14	24	23	22	27	8	35	36	32	24
25	Poland	23	25	24	23	17	12	28	26	26	20
26	Sweden	36	26	26	26	5	14	2	3	3	14
27	Argentina	21	27	30	29	32	16	33	33	31	22
28	Norway	40	28	28	28	10	18	1	1	1	12
29	Pakistan	5	29	29	30	40	30	40	40	40	11
30	Netherlands	32	30	32	32	9	7	17	17	15	29
31	Malaysia	26	31	25	25	28	34	29	22	23	2
32	Venezuela	27	32	34	36	29	40	27	31	35	31
33	U.Arab Emirates	37	33	31	31	31	31	5	4	4	10
34	Austria	38	34	39	35	8	6	6	16	10	40
35	Romania	30	35	38	39	20	25	26	32	33	37
36	Belgium	33	36	36	34	23	10	18	18	12	30
37	Kazakhstan	31	37	33	33	22	28	24	19	20	3
38	Switzerland	39	38	37	38	4	5	9	13	13	34
39	Czech Republic	34	39	35	37	6	15	16	12	18	18
40	Portugal	35	40	40	40	16	22	15	21	22	36

Definitions

Generation

Steam Power Plant:
The power plant in which the thermal energy in liquid, solid and gas fuels to generate steam and its consumption in steam turbines to generate electricity is used.

Gas Power Plant:
The power plant in which the thermal energy in liquid and gas fuels to generate hot gas and its consumption in gas turbines to generate electricity is used.

Combined Cycle Power Plant:
In a combined cycle power plant, the heat of the gas turbine's exhaust is used to generate steam by passing it through a heat recovery steam generator.

Diesel Power Plant:
A diesel power plant is the combination of a diesel engine with an electrical generator (often an alternator) to generate electrical energy.

Hydro-Electric Power Plant:
It is the term referring to electricity generated by hydropower; the production of electrical power through the use of the gravitational force of falling or flowing water.

Transmission and sub-transmission Network:
A network is included substations, overhead lines, cables and other electrical equipment to transit energy from power plants to end users.

Substation:
A substation is included a series of electrical equipment e.g. transformers, circuit breakers, disconnectors, instrument devices, in/out-coming feeders, reactor and capacitor and various Bays for transmission and distribution of electricity.

GIS Substation: A gas insulated substation is an electrical substation in which the major structures are contained in a sealed environment with sulfur hexafluoride gas as the insulating medium.

Voltage: Voltage is a difference between two points of a circuit

Transformer: A transformer is a static electrical device that transfers energy by inductive coupling between its winding circuits.

Distribution

Distribution Network: A series of medium and low voltage overhead lines, underground cables and substations to distribute electricity energy in an area.

Iran Electric Power Industry 2019-2020

Compiled by:
MOE. Tavanir Holding Company
Deputy of Research and Human Resources
Seyyed Hossein Sajadi
Tel: +98 21 88644944-5
Fax: +98 21 88644946

Management of Information, Communication Technology and Statistics:
Amireh Nikkhah
Tel: +98 21 27935561
Fax: +98 21 88644890

Supervised by:

Fahimeh Saadin
Fatemeh Maleki
Neda Rafiee Parsa
Morteza Pourtandorost
Rahman Charati
Maryam Zaker Hamidi

Management of Information, Communication Technology and Statistics:
Tavanir, Shahid Ghasemi Building, Rashid Yasemi St., Vali Asr Ave.
Tehran, Iran P.O.Box: 14155-6467

Web: http://amar.tavanir.org.ir
E-mail: infocdat@tavanir.org.ir